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PORT QUENDALL
CONTAMINATION INVESTIGATION

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INTRODUCTION

This report identifies the types of hazardous materials present in the soils and groundwater of the Port Quendall property, describes the hydrogeologic setting of the site, and provides a preliminary characterization of the magnitude and distribution of contamination on the property. The purpose of the report is to provide information for the preparation of conceptual remedial actions that are consistent with the development plans for the property.

The Port Quendall property is located on the southeastern shore of Lake Washington, west of the 44th Street overpass to Highway 405, and north of the commercial center of the City of Renton (Figure 1). Port Quendall is jointly owned by Puget Timber Incorporated and Altino Property Incorporated. At the present time, the property is leased to Seaboard Lumber Company for log storage.

Studies conducted for the evaluation of the property can be divided into the following elements:

- A review of geological, hydrological, and other available data pertinent to the property, including interviews with individuals knowledgeable on previous hydrogeologic studies of the area and past industrial activities conducted on the site.
- Drilling, soil sampling, and installation of monitoring wells.

- Excavation, logging, and sampling of trenches.
- Hydrologic testing and sampling of water monitoring wells.
- Laboratory analysis of water and soil samples.

This report is organized into the following sections:

1.0 INTRODUCTION

2.0 METHODS: Description of the methods used in conducting the studies outlined above.

3.0 GEOLOGY: Description of the geologic setting of the Port Quendall property

4.0 HYDROLOGY: Description of the groundwater hydrology of the property

5.0 HAZARDOUS MATERIALS:

Identification of the types of hazardous materials in the soils and groundwater on the property and preliminary evaluation of the quantities and distribution of these materials.

6.0 REFERENCES

Appendix A: Field Boring Logs

Appendix B: Field Water Sampling Data Sheets and Water Level Data Sheet

Appendix C: Transmissibility Calculations for Selected Wells

Appendix D: Analytical Methods and Results

DATA REVIEW

Prior to initiating field investigations, publications and other data relevant to an understanding of the hydrogeologic conditions on the property were reviewed. Primary sources of information included the library of the Washington State Department of Natural Resources, the University of Washington Library, and CH₂M-Hill Company. A listing of publications relevant to this study is provided in Section 6.0.

In addition to the literature review, aerial photographs of the project area taken in 1936, 1941, 1946, and 1960 were examined. These photographs made it possible to locate former stream channels, building sites, sumps, and other features of the property that could represent sites of potential contamination.

Meetings with the current owners of Port Quendall provided insight to earlier investigations conducted on the property and the nature of the industrial activities that occurred there. Mr. Ward Roberts, a former plant operations manager at the Reilly Tar and Chemical facility that used to occupy the property, furnished an interview and site tour. Mr. Roberts roughly mapped out the industrial facilities present on the property during his period of employment there, and described the nature of the chemical processing and landfill operations that took place at that time. Mr. Neil Twelker of Neil Twelker and Associates, Seattle, Washington, was interviewed with regard to his earlier geologic investigations

of the property. He provided a location map of borings and cross sections done by his firm in January 1971.

BORING AND SOIL SAMPLING

Data from the literature review, aerial photographs, and interviews were used to develop a base map of the likely areas of contamination on the property. These areas included the sites of chemical process buildings, tanks, and sumps; landfills containing industrial waste; and the original, filled-in channel of May Creek (Figure 2).

The base map was used to plan the soil and groundwater field investigations of the property. Soil borings, water monitoring wells, and trenches were located to verify likely areas of high contamination, as well as areas that contained minimal levels or no hazardous materials.

A total of 18 borings were drilled to an average depth of approximately 10 to 20 feet below the ground surface (Figure 2). The borings were limited to a maximum depth of about 20 feet in order to prevent possible transfer of contamination to or from deeper horizons when some of the borings were converted to water wells.

The borings were completed with a truck-mounted B-61 drill equipped with both 4- and 6-inch inside diameter (I.D.) hollow stem augers. If the boring was designated solely for soil sampling, or sampling and the installation of a 2-inch diameter well, the 4-inch I.D. auger was used for drilling. The 6-inch I.D. auger was used when a 4-inch diameter well was designated for installation after completion of the boring.

The soil sampling program was designed to obtain the maximum information on contamination in the upper 10 feet of the ground. As conditions permitted, samples were collected continuously in each boring to an average depth of 10 feet. Below that depth, the sampling interval was increased to an average of 4 to 5 feet to the bottom of the hole.

Two types of soil samplers were on hand throughout the program: an 18-inch long, 1-3/8-inch I.D. split spoon (ASTM D-1586) and a 3-foot long, 2.8-inch I.D. Shelby tube sampler. Successful recovery is accomplished with the split spoon sampler in granular or mixed soils, while the Shelby tube sampler is more effective in clay or clayey soils. Since good recovery was achieved with the split spoon, it was used throughout the program.

To collect the soil samples, the auger drill was advanced to the desired depth and the sampler was lowered through the center of the hollow stem with connecting rods. The connecting rod/sampler assembly was then driven into the soil with a 140 pound hammer. A record was kept of the number of blows required to drive the sampler.

After being driven into the soil, the sampler was removed, opened, and the soil sample was transferred to sterilized glass jars with teflon lids. These containers were supplied by Laucks Laboratories of Seattle, Washington. As the jars were filled and sealed, they were placed in ice chests at the site. The samples were taken in the chests to the laboratory on a daily basis to minimize excessive dissipation of volatiles prior to laboratory analysis. Each jar was labeled clearly with the boring number, sample number, and name of the attending geologist. In addition, sample depths and identification numbers were recorded on the field log for each boring. To establish the chain of custody, the samples were logged in at the laboratory as they were delivered.

Following removal of the sample, the split spoon was subjected to a three phase cleaning before reassembly to avoid contamination between samples. All components of the sampler were washed and scrubbed in soap and water. This was followed by a rinse with methyl alcohol and a final wash with triple distilled, deionized water. As a check on the thoroughness of the cleaning procedure, control samples of distilled water run

across the cleaned surfaces of the sampler, as well as the distilled water itself, were periodically taken to the laboratory for analysis. These samples were identified as the "W" series.

To prevent the possibility of transfer of contamination from one boring to another, augers and peripheral equipment were steam cleaned and scrubbed between borings. In addition, casings for each well were steam cleaned prior to installation. As a further precaution against contamination, all auger cuttings were shoveled into good quality reconditioned barrels and stored at each boring location. Lids were fixed on the barrels and the source boring for each barrel was marked in heavy felt pen for easy identification in future handling.

During drilling, a field log of each boring was taken by the onsite geologist. A rock/soil description, Unified Soil Classification System field designation, color, texture, moisture, sample number and depth, and standard penetration test (SPT) blow counts were recorded on the logs with depth. These logs are provided in Appendix A. A lithologic sketch log appears in one column using appropriate symbols for sand, clay, and other materials encountered during drilling. Another column was used on the log of each boring converted to a well to denote design placement of slotted screen and blank sections of casing. In borings used only for well installation, the log records only the design of the well.

WELL INSTALLATION, TESTING, AND SAMPLING

A total of 12 water monitoring wells were installed in borings on the Port Quendall property. These wells were designed to sample groundwater, provide a stationary, surveyed reference for measurement of static water levels, and provide data on aquifer performance.

Stainless steel screen and riser pipes were used in one well and the others were completed with threaded PVC screen and blank sections. Three of the wells were 2-inch I.D., while the remainder were 4-inch I.D. At

selected locations, multiple wells were installed so that separate intervals could be monitored independently. Well coordinates, ground elevations, and measuring point elevations for the top of each well casing were surveyed in by a registered surveyor. A summary of the physical specifications for each well including total depth, ground elevation, measuring point elevation, diameter, material for casing and screen, and coordinate location is provided in Table 1.

Each well was installed immediately following auger boring and soil sampling. After the auger drill was advanced to the desired depth, the well casing, including bottom cap, was lowered through the center of the auger and allowed to rest on the bottom of the hole. A sand-gravel pack was poured through the auger as it was removed from the hole to assure a good continuous pack around the annulus of the well screen or slotted section. This sanding process was discontinued one to two feet above the screened section and bentonite pellets followed by a bentonite-cement slurry was then placed in the annulus to provide a seal as a precaution against intercommunication between the surface and screened zones. Finally, a cement cap approximately one foot thick was poured flush with the ground to stabilize the well head. "As built" diagrams for the wells are provided on the log sheets in Appendix A.

Where PVC was used for casing material, threaded slotted and blank sections were used with no glue or adhesives of any kind as a precaution against this source of possible sample contamination. As previously mentioned, both stainless steel and PVC casing sections were thoroughly steam cleaned prior to installation.

Following completion, each well was jetted with air using a PVC pipe set in the casing and a trailer-mounted compressor unit. The jetting was performed to assure satisfactory initial flushing of the sand-gravel pack and to improve the flow of groundwater into the well. Each well was then pumped with an electric pump to remove an equivalent of three well volumes of water. This was done to assure that samples obtained from the

wells were representative of ambient groundwater conditions. If the well was incapable of delivering a satisfactory volume of water to the pump, hand bailing was employed to condition the well.

To prevent possible contamination, pump discharge was diverted directly into clean 50 gallon, closed-top drums. Each drum was labeled with the borehole number for ease of future identification and handling.

A detailed record of performance was maintained during the pumping and subsequent recovery period for each well. Prior to pumping, the static water level was measured and referenced to the surveyed measuring point on the top of the casing. The time and depth to water was noted during pumping and during the recovery period after pumping was stopped.

All static water level measurements were made with a steel tape accurate to 1/100 foot; recovery data was obtained using an electrical meter sounding device with a tested repeat accuracy equivalent to the steel tape. The use of the electric sounder was necessary because of the rapid changes in water levels observed during the recovery period.

Frequent water samples were taken during the pumping period and tested in the field to determine temperature, pH, and specific conductivity of the water. These measurements were taken with a thermometer, pH meter, and a conductivity-resistivity bridge. A summary of all information obtained during sampling is provided in Appendices B and C.

Following the pump and recovery testing, a sterilized teflon bailer of suitable diameter was used to bail an additional well volume from each well prior to sampling. Eye protection and vinyl gloves were used by field personnel to prevent accidental injuries that could result from contact with sample fluids. Water samples were carefully poured into preconditioned, labeled containers furnished by Laucks Laboratories, Inc. These samples were stored in an ice chest onsite until they could

be transported to the laboratory. Chain of custody procedures similar to those described for the soil samples were observed.

The bailer was subjected to the same three phase cleaning procedures as the split spoon between collection of each water sample. To further assure against contamination, new ropes were used on the bailers for each well sampled.

At the conclusion of water sampling, the static water level in each well was measured over a brief period of time using a chalked steel tape referenced to the surveyed measuring point marked at the top of each well casing. In addition, the level of Lake Washington was surveyed in at this time. This information is provided in Appendix B.

TRENCHING.

In an effort to augment the drilling program, a limited amount of trenching was performed on the Port Quendall property. The principal objectives of the trenching were to delineate with some accuracy the alignment or location of the original May Creek channel (1917 to 1930) identified during meetings with Mr. Ward Roberts, and to provide a preliminary assessment of the vertical and lateral distribution and nature of the fill disposed on the site from the Pacific Car and Foundary Company or other sources.

A total of four trenches having a combined or cumulative length of 252 feet were excavated to depths averaging 8 feet using a backhoe with a 36-inch wide bucket. The locations of these trenches are provided in Figure 2.

Upon completion of the excavation, a scale detailed log was made of each trench (Figures 3 and 4). A string level line was placed along one

wall of the trench for vertical reference and a reel tape was used along this line for stationing or horizontal control. Following a preliminary visual inspection of the entire trench, significant features including soil types, lithologic contacts, contaminant seeps, cultural debris, and sample locations were sketched in using a small hand tape to provide a reference to the established level line and stationing.

Soil samples were collected at selected locations within the trenches using a small scraper. These samples were placed in sterilized glass jars with teflon lids provided by Laucks Laboratories, Inc. Onsite storage of the samples and transfer procedures to the laboratory were identical to those used for the samples collected from borings. At the conclusion of sampling, each trench was backfilled and the surface restored to its original contour.

LABORATORY ANALYSES

Table 2 lists the various methods used to analyze the soil and water samples and the number of samples analyzed by each method. The soil samples were screened for polycyclic aromatic hydrocarbons (PAH) by absorbance. This method involves methylene chloride extraction, evaporation of the methylene chloride, and re-dissolving the extract in cyclohexane, followed by measurement of the absorbance at 250 nanometers. The absorbance was compared with benzo(a)pyrene standards.

Absorbance was used instead of fluorescence to screen PAHs because of the inability to visually compare fluorescence sample extracts with benzo(a)pyrene standards. This inability is caused by differences in fluorescent color.

Uncertainties in the absorbance screen can be caused by the presence of such compounds as naphthalene, ace-naphthylene, and ace-napthene in the

extract. These compounds tend to quench absorption of higher ring compounds. Absorption cannot distinguish PAHs of different ring size. Further description of the procedure used for the absorption screening is contained in Appendix D.

In addition to using the absorbance screen to determine PAH concentrations, a Washington State Department of Ecology (DOE) method was used to determine the PAH concentration in six soil samples for cross-comparison purposes. The DOE method uses a series of extractions to isolate PAH compounds followed by evaporation and weighing. An optional analysis step of the DOE procedure uses high pressure liquid chromatography (HPLC) to separate 2- and 3-ring PAHs from the larger ring PAHs. These larger ring compounds are the only PAHs considered in the DOE definition of an extremely hazardous waste on the basis of PAH content. This optional analysis step was used in the study.

The volatile organic screen for soil samples was performed by an extracting procedure followed by gas chromatographic (GC) analysis. Selected extractions followed by a gas chromatograph/mass spectrometer (GC/MS) scan were used in the analysis for priority pollutants. The GC/MS results provide an additional measure for determining and cross-checking PAH concentrations. Polycyclic aromatic hydrocarbons would appear in the GC/MS scan of the base-neutral extract.

The PAH content of water samples was determined by the same general DOE method used for soil samples. The optional HPLC analysis step was performed for separation of the PAHs of different ring sizes.

Volatile aromatics in water were determined by use of a purge-and-trap procedure followed by GC analysis. A photoionization detector was used following passage of the volatiles through the GC.

Pentachlorophenol concentrations in water samples were determined by the Sep-Pak method which involves acidification, passage of the water through an activated Sep-Pak, elution of the Sep-Pak, followed by HPLC analysis. Further discussion of this method is provided in Appendix D.

Quality Assurance and Control

A quality assurance/control program was instituted for the laboratory analyses of soil and water samples collected at the Port Quendall property. The program included the use of three techniques:

- replicate analyses for the mineral (inorganic) constituents, 2,4,6-trichlorophenol, pentachlorophenol, benzo(k)fluoranthene, and total PAHs to determine the relative or absolute error in replicate analysis
- spiking studies to define the accuracy of the results obtained on the mineral parameters
- surrogate blind spiking for benzo(k)fluoranthene and 2,4,6-trichlorophenol to define the accuracy of data generated for these parameters.

The results of the replicate analysis and spiking studies are presented in Appendix D. Appendix D-1, which reports the replicate analysis, indicates that the results obtained for the mineral parameters are highly reproducible in spite of the lack of established control limits. The relative error values for the organic parameters indicated that the methods performed very effectively, except in the case of 2,4,6-trichlorophenol. A large disparity between duplicate analyses for the 2,4,6-trichlorophenol indicates that the "standard" analytical methodology used for this compound may need to be modified if extensive monitoring is undertaken on the property. Spiking results presented in

Appendix D-2 for the mineral parameters indicate that the data for these compounds is highly accurate. Appendix D-3 presents data for the surrogate recovery of benzo(k)fluoranthene and 2,4,6-trichlorophenol. These data indicate that benzo(k)fluoranthene was present in some of the samples making it an inappropriate choice as a surrogate blind spiking compound and that some samples had a large organic matrix which possessed an affinity for 2,4,6-trichlorophenol, interfering with the extraction process.

The three 2,4,6-trichlorophenol recovery values which indicated an interference were either within the control limit bounds or slightly below the lower control limit. These results indicate that the removal of the selected compounds is less than quantitative (100 percent) by the extraction step of the analytical method. This result is neither surprising nor a flaw in the experimental design. It indicates that either the analytical method requires "tuning" to be appropriate for gathering quantitative data, or the data need to be corrected for recovery of 2,4,6-trichlorophenol.

The Port Quendall property is located on a delta/alluvial fan complex which developed at the original mouth of May Creek where it flowed into Lake Washington. The creek has been diverted several times and since 1969, it has flowed in a south-southwesterly direction across the eastern side of the delta/fan, entering Lake Washington at the southern end of the Barbee Mill property. This property is located immediately south of Port Quendall.

Prior to 1916, about three quarters of the delta/fan area exposed today was below lake level. In that year, the ship canal was cut between Lake Washington and Union Lake, resulting in the lowering of Lake Washington from 22 feet to 14 feet above sea level (Liesch et al. 1963). This exposed much of the delta, and since that time considerable filling has been done to accommodate use of the property.

The May Creek delta/fan complex consists of sands, clay, silt, gravel, and in some locations, abundant peat interbeds, all overlain by recent fill. Source materials of the natural deposits include drift and till units incised by the creek.

A cross section drawn roughly on a east-west axis through the center of the property is provided in Figure 5. (The location of the cross section is shown in Figure 2.) As can be seen in the figure, there is too much variability in the materials composing the delta to correlate

lithology between the borings used to construct the cross section. Highly variable lithology is typical of alluvial fan/delta complexes where braided channels continuously meander back and forth across the surface, depositing lenses of gravel and coarse sand in channels and finer materials along the flanks, creating an irregular stratigraphic record during the course of deposition.

It is postulated that the May Creek delta/fan is underlain by the lower clay unit described by Liesch et al. (1963) (see on Figure 6). Liesch suggests that this unit is relatively widespread in northwestern King County. It outcrops to the north of the Port Quendall property on Mercer Island and the mainland. The unit underlies the southeastern arm of Lake Washington and Mercer Island, dipping gently westward along both its upper and lower contacts.

The lower clay unit is approximately 50 feet thick and is composed almost entirely of gray, blue, and brown clay and silt. The unit is thick bedded to laminated and was deposited for the most part in standing water, with the clay being locally varved. Wells drilled into the lower clay unit in northwest King County are reported to yield little water. It appears that the unit acts as an aquitard, inhibiting the downward movement of water from younger sediments.

The total thickness of the May Creek delta/fan is not yet known. the delta/fan was not penetrated during the drilling program conducted for this study. A previous exploration program (Twelker 1971) with borings up to 61 feet deep does not appear to have reached the bottom of the delta/fan either since a stratigraphic unit similar to the lower clay unit is not shown on the cross sections generated from that program.

Twelker (1971) indicates that the delta/fan can be divided into at least an upper and lower unit. He has described the upper unit as a

loose to medium-dense sand with thin layers of peat and silt. The lower unit consists of dense sand with gravel lenses and no peat. Based on this description, borings conducted for the current study were located in the upper unit of the delta/fan.

Trench T-1 cut across the original May Creek channel on the east side of the Port Quendall property (Figures 2 and 3). The log for this trench clearly defines the margins of a channel containing clay, sand and gravel lenses, and abundant cultural debris including tar fragments, bricks, and wood. The delta deposits flanking the channel, as well as the channel itself, appear to be overlain by a relatively recent aggregate fill averaging two feet in thickness with a thin silt layer at the surface.

Trench T-2 was located near the center of the old May Creek channel. The stratigraphic relationship between the channel and fill deposits in this trench was similar to that of trench T-1 (Figure 3). Mobile creosote began to seep from the walls of T-2 at several levels throughout the time that the excavation was open.

Trench T-3 was sited along the center line of the original May Creek channel. The log for this trench shows the somewhat irregular but distinctive erosional contact of the channel with underlying delta/fan deposits (Figure 3). Channel deposits exposed in the T-3 excavation consisted of sand, silt, metal, and tar fragments. Mobile creosote seeped from the channel section of the walls of the trench during the time that the excavation was exposed. An iridescent sheen appeared on the surface of groundwater which accumulated in the floor of the trench accompanied by a heavy hydrocarbon odor. Channel and delta/fan deposits in the trench were covered by a 2- to 3-foot thick mantle of fill consisting of silt and wood fibre shavings.

Trench T-4 was positioned to determine the type of fill or possible contaminants present in the area reported to have been used for industrial fill from the Pacific Car and Foundry Company. The log for T-4 (Figure 4) shows a variety of semi-stratified fill materials including sand, tar fragments, metal, brick, glass, and wood fiber. In addition, mobile creosote seeped from the walls near the south end of the trench at the time it was excavated. It appears that undisturbed delta/fan deposits consisting of sand and gravel with clay lenses occupied the lower $\frac{1}{4}$ to $\frac{1}{2}$ of the trench between approximately Station 0 and Station 42 (Figure 4). A seep or spring line is present along the top of the undulating contact between the delta/fan and overlying fill material near the south end of the trench.

Boring BH-5 was located approximately 17 feet from the south end of Trench T-4. Contamination was noted as deep as 20 feet in that boring. By extrapolation, it is conceivable that contamination may exist to at least that depth in permeable materials below Trench T-4, having migrated from upper horizons. On the basis of findings in Trench T-4, it would appear that contaminated fill covers much of the area north of the tank farm (Figure 2).

Groundwater hydrology characteristics may vary across the Port Quendall property in response to the variability in the stratigraphy and lithology of the May Creek delta/fan sediments. However, some general trends in the groundwater regime can be identified.

Recharge of the groundwater aquifer on the property occurs primarily in the upper reaches of the May Creek drainage basin, which covers approximately 8100 acres (CH₂M-Hill 1977). However, some recharge also occurs by infiltration of precipitation that falls directly on the site. The surface of the groundwater table on the property slopes toward the northwest, and varies from a mapped elevation of almost 19 feet near the site of the former Rielly Tar and Chemical Company still house to about 15 feet at Lake Washington (Figure 7). This results in a groundwater surface gradient of about 42 feet/mile (0.0079 foot/foot) with a total hydraulic head of about 6 feet across the property. Based on an examination and review of the local geology, the stratigraphy exposed in exploration borings, and the study of the depositional environment of the May Creek delta/fan, it is interpreted that groundwater discharge is into the sub-bottom of Lake Washington in the near shore environment.

Although the groundwater surface on the property is generally uniform (as indicated by the generally uniform pattern of the water level surface contours), there are some variations. For example, in the southwestern

portion of the property, near boring BH-12, the groundwater surface contours become closely spaced and skewed toward the shoreline of Lake Washington (Figure 7). At this location, the groundwater gradient increases to about 95 feet/mile (0.018 foot/foot) and may reflect local semi-confined groundwater conditions resulting from the variable nature of the delta/fan sediments. In the northeastern corner of the property, the water level contours are less closely spaced resulting in a lower gradient of about 19 feet/mile (0.0036 foot/foot). This variation may also be caused by the variable nature of the sediments.

A study of the coefficient of transmissibility across the property, as calculated from pump tests at selected wells, illustrates the variability of local groundwater flow. Transmissibility of an aquifer is a measure of the rate of flow of water subject to a unit hydraulic head through a vertical strip of soil one foot high. In general, relatively high values of transmissibility indicate high rates of groundwater movement. Table 3 lists the calculated values of transmissibility at five selected wells on the Port Quendall property. Based on estimates of saturated thickness provided in the boring logs and estimates of representative porosity for the sediments, the velocity of groundwater travel at each boring was estimated. As indicated in Table 3, the estimated groundwater velocities across the site vary from about 7 feet/year to almost 60 feet/year and are greatest near the center and southwestern portion of the property.

The following section provides a preliminary evaluation of the location and levels of hazardous materials present in the soils and water of the Port Quendall property. The purpose of this information is to guide the development of conceptual remedial actions for the property.

SOILS

As discussed in Section 2.0, 134 soil samples from the Port Quendall property were screened for PAH concentrations by an absorbance technique. This technique provided a cost-effective method for determining semi-quantitative PAH levels in a large number of samples. Table 4 provides a quality assurance comparison of six soil samples simultaneously analyzed for PAHs by the absorption technique and the DOE gravimetric method. The PAH concentrations determined by the absorption and DOE methods agreed within a factor of three for four of the six samples and within a factor of 30 for the remaining two samples. Agreement within a factor of three is considered good when the relatively low concentrations of PAHs, nonspecificity of the absorbance screen (i.e., does not exclude 2- and 3-ring compounds which are not considered in the DOE definition of PAHs), and potential uncertainties in the screen concentrations are taken into account. The agreement between the methods for the one sample with greater than 0.1 percent PAH was particularly good. The PAH concentrations of three samples determined by GC/MS scans (Table 4) are much lower.

than the results of the other two methods. This could be indicative of the uncertainties of quantitative analyses by GC/MS without analyzing standards for the compounds of specific concern.

Table 5 lists the results of the absorbance screen for PAHs and Figure 8 presents a spatial plot of these data. The highest concentration of PAHs was 4.8 percent (weight percent as benzo(a) pyrene), found at a depth of 4.5 to 6 feet in borehole BH-1. This borehole is located on the northern end of the property. Polycyclic aromatic hydrocarbons at concentrations equal to or greater than one percent were present in some samples from all of the borings and trenches except in the southeastern (boreholes BH-10, BH-11, BH-12, BH-14, and BH-15) and extreme western (borehole BH-2 and trench T-2) portions of the property. Soils with a PAH concentration of one percent (when more than 400 pounds of material are present) are defined as "extremely hazardous waste" by the DOE.

It is possible that significant near-surface concentrations of PAHs could be present in borehole BH-10. A soil sample taken from 1 to 1.5 feet in this hole had a PAH concentration of 0.63 percent. The actual concentration could be higher because of analytical uncertainty or a heterogeneous occurrence of PAHs in this zone. Additional samples from trench T-2 could also reveal significant PAH concentrations since one of the two samples collected from the trench has a concentration of 0.50 percent.

Tables 6 and 7 show non-PAH priority pollutants and other compounds detected in the soil samples. Based on GC/MS scans, aromatic hydrocarbons with two and three aromatic rings were present at levels of approximately 100 to 2000 mg/kg (ppm) in composite soil samples from boreholes BH-7 and BH-9 (Table 6). It should be noted that two and three aromatic-ring hydrocarbons are not considered in the DOE definition of PAHs because of their lower toxicity relative to higher ring compounds.

The detected two-ring compounds were naphthalene, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, and fluorene. The detected three-ring compounds were fluoranthene and phenanthrene. Naphthalene was the compound present at the highest level in the samples, with concentrations of 1139 ppm (0.11 percent) and 2168 ppm (0.22 percent) in samples from BH-7 and BH-9, respectively. These concentrations should be regarded as only semi-quantitative since standards for the specific two- and three-ring compounds were not run with the samples.

Volatile organics were detected by GC/MS scan in the ppm concentration range in the composite soil samples from BH-7 and BH-9 (Table 6). This level of volatile organics was also present in the sample from the 18 to 19.5-foot interval of BH-7 (Table 7). The volatile organics detected in the samples included five aromatic compounds (benzene, toluene, xylene, methylbenzene/styrene, ethylbenzene, and methylene chloride) and one halogenated aliphatic compound (methylene chloride).

Other non-PAH compounds detected in the soil samples include:

- acid-extractable phenolic compounds at the ppm level (the priority pollutant 2,4 dimethylphenol and two non-priority compounds)
- base-neutral extractable non-priority compound at the ppm level (dibenzofuran)
- pesticides at the part-per-billion (ppb) level (aldrin and possibly heptachlor).

Other tentatively identified compounds from the GC/MS scan of the composite soil samples are included in Appendix D.

Except for halogenated organics, the DOE hazardous waste criteria do not specifically address non-PAH compounds. Criteria for definition of a "dangerous waste" or "extremely dangerous waste" exist that are based on total equivalent concentrations and quantities of mixtures of chemicals based on their carcinogenic and toxic properties. Wastes exceeding 400 pounds that contain halogenated hydrocarbon concentrations of 0.01 to 1.0 percent are considered to be a "dangerous waste" by the state. Composite soil samples from BH-7 and BH-9 have only 0.002 and 0.004 percent, respectively, of halogenated organics (methylene chloride).

It does not appear that the field exploration program reached the bottom of contamination on the Port Quendall property. Levels of PAH approaching one percent were found at the 21.6 to 23-foot interval of borehole BH-5. Twelker (1971) found hydrocarbon odor near the bottom of holes drilled to a depth of approximately 60 feet, although this could have easily been the result of contamination carried down from much higher horizons.

WATER

Based on an analysis of inorganic constituents (Appendix D), the groundwater on the property is fresh (i.e., low dissolved solids) and varies in hardness from moderately hard (61 to 120 mg/l of CaCO_3) to very hard (more than 180 mg/l of CaCO_3). The pH of water varies from slightly acidic (6.1) to slightly alkaline (7.8).

Table 8 lists the results of the organic analyses of the water samples and Figure 8 provides a spatial plot of these data. Polycyclic aromatic hydrocarbons were present in all 12 groundwater samples from the property, ranging in concentration from 6 ug/l to 23 mg/l.

The DOE uses water quality criteria recommended by the U.S. Environmental Protection Agency (EPA) in the November 28, 1980 Federal Register for their evaluation of potential priority pollutants in water (personal communication, G. Brugger, DOE, August, 1983). The EPA does not have recommended limits for PAHs, although toxicity and risk-level data are presented.

Polycyclic aromatic hydrocarbon concentrations greater than 1 mg/l were present in water samples from wells BH-5, BH-5A, BH-8, BH-8A, and BH-2A. With the exception of water samples from wells BH-2A and BH-12, groundwater containing more than 100 ug/l of PAHs occurred in wells where soil samples had more than one percent PAHs. In wells where soil samples were found to have less than one percent PAHs, the corresponding water samples contained less than 100 ug/l of these compounds (Figure 8). In general, PAH concentrations were higher in shallow groundwater than in deeper groundwater samples.

The PAH concentration in the water sample from well BH-2A (2.64 mg/l) appears to be anomalously high. Soil from boring BH-2 had very low PAH concentrations and water from well BH-2, which is adjacent to well BH-2A and screened at the same depth interval, had a PAH concentration of only 5.7 ug/l. The anomalously high value could possibly be the result of cross-contamination during sampling.

The PAH concentration in the water from BH-12 (745 ug/l) appears to be high relative to the low soil PAH concentrations in the boring (0.004 percent maximum). The high PAH concentration in the water could be due to migration of these compounds from up-gradient sources along the old May Creek channel. The high concentrations could also be a result of cross-contamination during sampling.

Volatile aromatic hydrocarbons were present at detectable concentrations in 8 of the 12 groundwater samples. Benzene, toluene, and xylene (BTX) concentrations ranged from several ug/l to approximately 17 mg/l. The concentrations of each of these compounds were generally equal to or greater than 1 mg/l in samples from wells BH-5, BH-5A, BH-8, and BH-8A. It should be noted that boreholes BH-5 and BH-8 had the highest soil PAH concentrations. It is possible that the high PAH values were observed as a result of their extraction from soil by the BTX solution. The absence of detectable volatile organics in the water sample from BH-2A is further evidence that the high PAH reading for the sample is anomalous.

Five of the groundwater samples were analyzed for pentachlorophenol. Only the sample from BH-8 contained a detectable concentration of this compound (86 ug/l). No concentration limits for aromatic hydrocarbons or pentachlorophenol have been promulgated by the EPA for freshwater aquatic life or human health, although toxicity and risk-level data have been presented in the Federal Register.

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Table 1. MONITORING WELL INSTALLATIONS

Well	Total Depth (ft)	Ground Elev. (ft)	M.P. Elev. ^a (ft)	Dia. (in)	Material	Monitored Interval (ft)	North Coordinate	East Coordinate
BH-1	19.5	23.4	23.42	2	PVC	5-19.5	197,782	1,662,516
BH-2	19.5	20.8	25.47	2	PVC	5-19.5	197,633	1,662,767
BH-2A	20.0	20.8	25.06	4	Stainless	5-20.0	197,630	1,662,762
BH-5	32.0	32.3	25.64	4	PVC	13-23.0	197,473	1,662,136
BH-5A	10.0	23.3	24.38	4	PVC	5-10.0	197,406	1,662,136
BH-6	19.5	20.0	21.85	4	PVC	8-18.0	197,406	1,662,227
BH-8	24.5	23.4	25.12	4	PVC	13-23.0	197,342	1,662,426
BH-8A	10.0	23.4	23.64	4	PVC	5-10.0	197,336	1,662,426
BH-10	19.5	21.5	22.50	4	PVC	5-19.5	197,331	1,662,981
BH-12	23.0	21.9	24.39	4	PVC	13-23.0	197,106	1,662,862
BH-12A	10.0	21.9	21.41	4	PVC	5-10.0	197,106	1,661,855
BH-15	19.5	21.9	21.70	2	PVC	5-19.5	196,970	1,661,914

Notes: Parentheses with coordinates indicates survey by WCC personnel. All other survey data obtained by Ken J. Oyler, CE & LS #5524.

^a M.P. denotes measuring point at top of installed casing used for various hydrologic measurements.

Table 2. ANALYTICAL METHODS USED FOR THE ANALYSIS OF SOIL AND WATER SAMPLES

Parameter	Number of Samples	Method
<u>SOIL</u> ^a		
PAH ^b Screen	134	Absorbance of extract
Total Soil PAHs	6	Appendix G of 173-303 WAC ^c (3/82)
Volatile Organic Screen	6	EMSL-LV ^d No. 1 (11/10/81)
Priority Pollutants	2 Composites (all fractions), 3 samples (base-neutral extract only)	EMSL-LV No. 2 (11/10/81) for extraction; EPA methods 624 and 625 for analysis
<u>WATER</u>		
PAHs	12	Appendix G of 173-303 WAC, 3/83
Volatile Aromatics	12	EPA Method 602
Pentachlorophenol	5	Sep-Pak Method
pH	12	EPA Method 150.1
Total Alkalinity	12	EPA Method 310.2
Conductivity	12	EPA Method 120.1
Sodium	12	EPA Method 273.1
Calcium	12	EPA Method 215.1
Magnesium	12	EPA Method 242.1
Potassium	12	EPA Method 258.1
Chloride	12	EPA Method 325.1
Sulfate	12	EPA Method 375.4
Nitrate-Nitrite	12	EPA Method 353.2
Total Phenols	3	EPA Method 420.1

^a Boring and trench soil samples.

^b Polycyclic aromatic hydrocarbons.

^c Washington State Administrative Code.

^d U.S. EPA Environmental Measurement System Lab. - Las Vegas.

Table 3. CHARACTERISTICS OF GROUNDWATER MOVEMENT ON THE PORT QUENDALL PROPERTY

Well Number	Transmissibility gpd/ft	Estimated Velocity, ft/yr
BH-2A	104	7.3
BH-6	453	58.4
BH-8	76	7.3
BH-10	250	18.3
BH-15	484	32.9

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Table 4. CROSS-COMPARISON OF PAH CONCENTRATIONS DETERMINED BY DIFFERENT METHODS

Method	Sample (Concentration % by weight)						
	BH-2/D-2	BH-4/D-4	BH-6/D-4	BH-9/D-7	BH-10/D-5	BH-11/D-8	BH-7 Comp.
Absorbance Screen ^a	0.057	0.46	0.03	0.06	0.0064	0.02	0.74-0.97
DOE Method	0.002	0.44	0.01	0.03	0.002	0.01	—
GC/MS (2 or 3 aromatic rings)	—	0.045	—	—	—	0.0011	0.30
(more than 3 aromatic rings)	—	0.019	—	—	—	0.0006	0.08

^a Concentration in terms of percentage as benzo(a)pyrene

Table 5. ANALYTICAL RESULTS FOR POLYCYCLIC AROMATIC HYDROCARBON (PAH)
SCREENING OF SOIL SAMPLES FROM THE QUENDALL PROPERTY^a

Boring	Sample	Location ^b	Depth (feet)	PAH Concentration ^c
<u>Boring Samples</u>				
BH-1	D-1		0-1.5	0.002
	D-2		3-4.5	0.93
	D-3		4.5-6	4.8
	D-4		6-7.5	L/0.002
	D-5		7.5-9	0.001
	D-6		12.9-14.4	0.004
	D-7		18-19.5	0.009
BH-2	D-1		0-1.5	L/0.001
	D-2		3-4.5	0.002
	D-3		4.5-6	0.003
	D-4		6-7.5	L/0.001
	D-5		7.5-9	L/0.001
	D-6		12.9-14.4	0.001
	D-7		18-19.5	L/0.001
BH-4	D-1		0-1.5	L/0.001
	D-2		4.5-6	0.002
	D-3		9-10.5	0.056
	D-4		10.5-12.0	0.44
	D-5		12.9-14.4	3.4
	D-6		19-19.5	0.75
	D-7		21.7-23.2	0.041
BH-5	D-1		0-1.5	0.73
	D-2		1.5-3	1.0
	D-3		3-4.5	0.90
	D-4		4.5-6	0.89
	D-5		6-7.5	0.89
	D-6		7.5-9	0.006
	D-7		12.9-14.4	0.006
	D-8		18-19.5	1.9
	D-9		21.6-23.1	0.71
BH-6	D-1		3-4.5	1.0
	D-2		4.5-6	0.023
	D-3		6-7.5	0.94
	D-4		7.5-9	0.01
	D-5		12.9-14.4	0.002
	D-6		18-19.0	0.001

Table 5. ANALYTICAL RESULTS FOR POLYCYCLIC AROMATIC HYDROCARBON (PAH)
SCREENING OF SOIL SAMPLES FROM THE QUENDALL PROPERTY^a (continued)

Boring	Sample	Location ^b	Depth (feet)	PAH Concentration ^c
BH-7	D-1		3-4.5	0.91
	D-2		4.5-6	0.081
	D-3		6-7.5	0.74
	D-4		7.5-9	0.97
	D-5		9-10.5	0.88
	D-6		12.9-14.4	0.001
	D-7		18-19.0	0.001
BH-8	D-1		0-1.5	0.86
	D-2		1.5-3	0.054
	D-3		3-4.5	0.013
	D-4		4.5-6	0.94
	D-5		6-7.5	1.2
	D-6		7.5-9	1.1
	D-7		12.9-14.4	1.8
	D-8		18-19.5	1.3
	D-9		23-24.5	0.042
BH-9	D-1		0-1.5	0.005
	D-2		1.5-3	1.7
	D-3		3-4.5	2.2
	D-4		6-7.5	1.3
	D-5		7.5-9	0.014
	D-6		9-10.5	1.0
	D-7		12.9-14.4	0.03
	D-8		18-19.5	L/0.001
BH-10	D-1		0-1.5	0.63
	D-2		1.5-3	0.009
	D-3		3-4.5	0.002
	D-4		4.5-6	0.002
	D-5		6-7.5	0.002
	D-6		12.9-14.4	L/0.001
	D-7		18-19.5	L/0.001
BH-11	D-1		0-1.5	0.007
	D-2		1.5-3	0.017
	D-3		3-4.5	0.002
	D-4		4.5-6	0.002
	D-5		6-7.5	0.003
	D-6		7.5-9	0.003
	D-7		12.9-14.4	L/0.001
	D-8		18-19.5	0.01

Table 5. ANALYTICAL RESULTS FOR POLYCYCLIC AROMATIC HYDROCARBON (PAH)
SCREENING OF SOIL SAMPLES FROM THE QUENDALL PROPERTY^a (continued)

Boring	Sample	Location ^b	Depth (feet)	PAH Concentration ^c
BH-12	D-1		1.5-3	0.004
	D-2		3-4.5	L/0.001
	D-3		4.5-6	0.001
	D-4		6-7.5	0.003
	D-5		12.9-14.4	0.001
	D-6		18-19.5	0.003
	D-7		21.9-23.4	L/0.001
BH-14	D-1		0-1.5	0.022
	D-2		3-4.5	0.007
	D-3		4.5-6	0.007
	D-4		6-7.5	L/0.001
	D-5		7.5-9	0.009
	D-6		12.9-14.4	L/0.001
	D-7		18-19.5	L/0.001
BH-15	D-1		0-1.5	0.004
	D-2		3-4.5	0.008
	D-3		4.5-6	0.002
	D-4		6-7.5	L/0.001
	D-5		7.5-9	L/0.001
	D-6		12.9-14.4	0.002
	D-7		18-19.5	0.001
BH-16	D-1		0-1.5	0.004
	D-2		1.9-3.4	1.1
	D-3		3.4-4.9	0.001
	D-4		4.9-6.4	L/0.001
	D-5		6.4-7.9	d
	D-6		7.9-9.4	L/0.001
	D-7		9.4-10.9	L/0.001
	D-8		12.9-14.4	L/0.001
	D-9		18-19.5	L/0.001
<u>Trench Samples</u>				
T-1	1	39.1	2.5	0.67
	2	39.1	3.8	0.73
	3	39.1	5.0	0.008
	4	31.9	4.4	0.37
	5	47.8	3.1	1.3

Table 5. ANALYTICAL RESULTS FOR POLYCYCLIC AROMATIC HYDROCARBON (PAH)
SCREENING OF SOIL SAMPLES FROM THE QUENDALL PROPERTY^a (concluded)

Boring	Sample	Location ^b	Depth (feet)	PAH Concentration ^c
T-1 (cont.)	6	20.0	5.6	0.002
	7	46.9	5.6	L/0.001
	8	39.1	1.3	L/0.001
T-2	1	7.5	0.94	0.002
	2	6.3	3.75	0.50
T-3	1	19.7	3.75	0.32
	2	19.7	5.3	0.84
	3	19.7	7.5	1.0
	4	30.6	5.9	1.2
T-4	1	100.6	4.7	1.9
	2	100.6	6.6	0.43
	3	100.6	8.1	0.080
	4	51.3	3.1	0.28
	5	51.3	5	0.48
	6	51.3	6.9	1.7

^a Screening by measurement of absorbance of extract and comparison to benzo(a)pyrene standards.

^b Feet from southern end of trench.

^c % PAH by weight of soil as benzo(a)pyrene; L/# = Below detection level of #.

^d Sample not analyzed.

Table 6. CONCENTRATIONS OF TOTAL PAHS AND SELECTED NON-PAH COMPOUNDS DETECTED IN GC/MS SCANS OF EXTRACTS OBTAINED FROM TWO SOIL COMPOSITES^a

Extract	Compound	Concentration (ppb)	
		BH-7 Comp	BH-9 Comp
Acid	2,4-Dimethyphenol ^b	27,500	14,000
	2-Methylphenol	15,700	7,800
	4-Methylphenol	30,400	L/4,000
Base/Neutral	Total PAH Compounds	659,600	1,141,500
	(>3 rings) ^b		
	Acenaphthene ^b	159,300	515,000
	Fluoranthene ^b	166,800	368,000
	Napthalene ^b	1,139,000	2,168,000
	Acenaphthylene ^b	71,500	185,000
	Anthracene ^b	74,400	258,000
	Fluorene ^b	96,500	279,000
	Phenanthrene ^b	304,300	1,061,000
	Dibenzofuran	72,900	139,000
	2-Methylnapthalene	265,000	1,083,000
Volatile	Benzene ^b	1,130	2,300
	Ethylbenzene ^b	27,000	34,600
	Methylene Chloride ^b	19,300	36,700
	Toluene ^b	10,150	12,000
	O-Xylene	58,400	56,900
Pesticides	Aldrin ^b	7	130
	Heptachlor Epoxide ^{cb}		50

^a Only priority pollutants and readily identifiable non-priority pollutants are listed. Other tentatively-identified compounds are listed in Appendix D. Two and three ring aromatic compounds (which are not considered to be PAHs by the Washington State DOE) are listed.

^b Priority pollutants.

^c Possible positive matrix interference.

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Table 7. RESULTS OF THE SCAN FOR VOLATILE ORGANIC COMPOUNDS IN THE SOIL SAMPLES^a

Compound	Sample					
	BH-2/D-2	BH-4/D-4	BH-6/D-4	BH-9/D-7	BH-10/D-5	BH-11/D-8
Benzene	L/0.2	0.3	L/0.2	2.1	L/0.2	L/0.2
Toluene	L/0.2	L/0.2	L/0.2	5.2	L/0.2	L/0.2
Xylene	L/0.4	L/0.4	L/0.4	7.3	L/0.4	L/0.4
Methyl benzene & Styrene	L/0.4	L/0.4	L/0.4	4.3	L/0.4	L/0.4

^a Concentration in units of ppm; L/# = Below the detection level of #.

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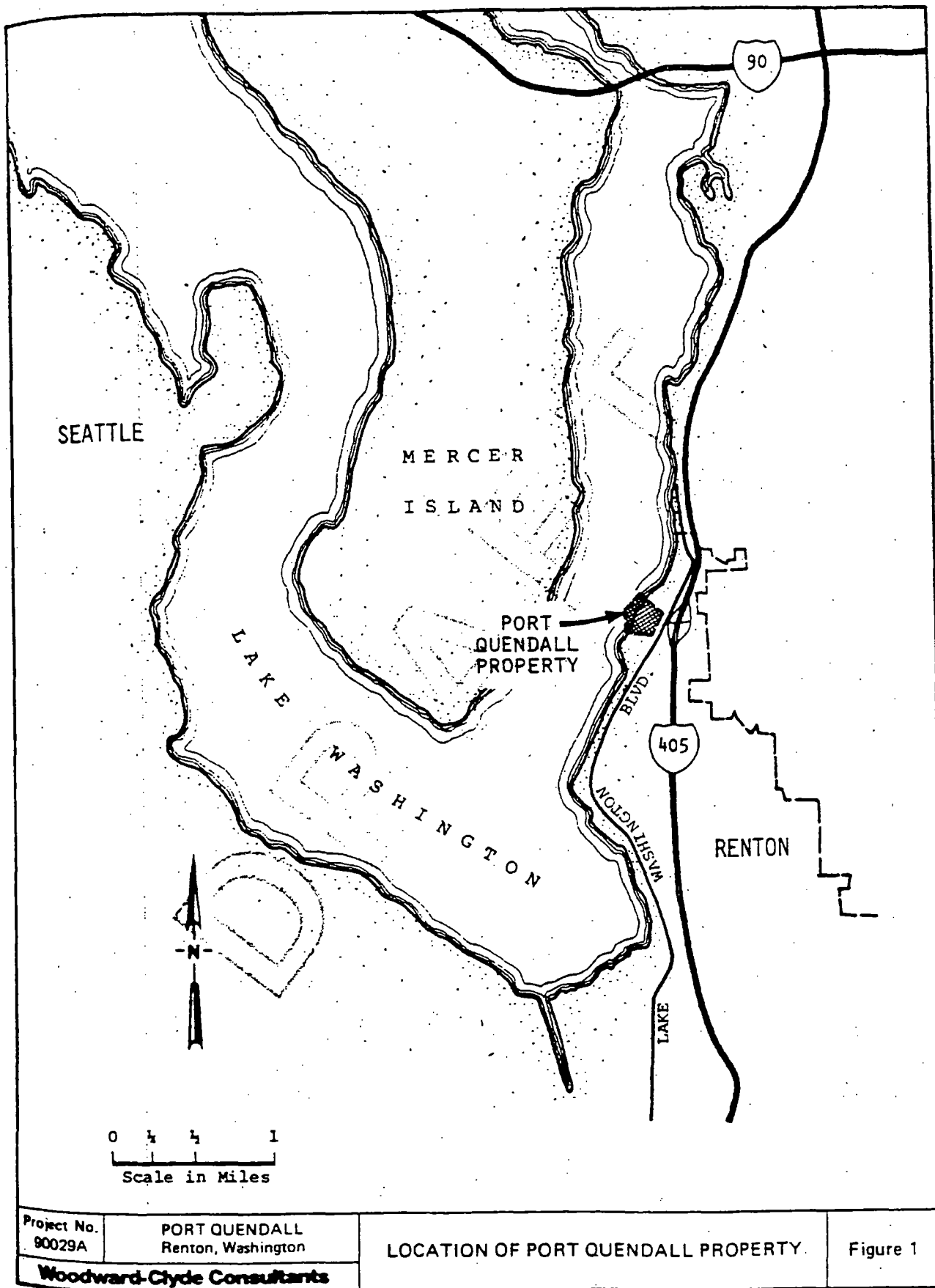
Table 8. CONCENTRATIONS OF SELECTED ORGANIC CONSTITUTENTS IN WATER SAMPLES

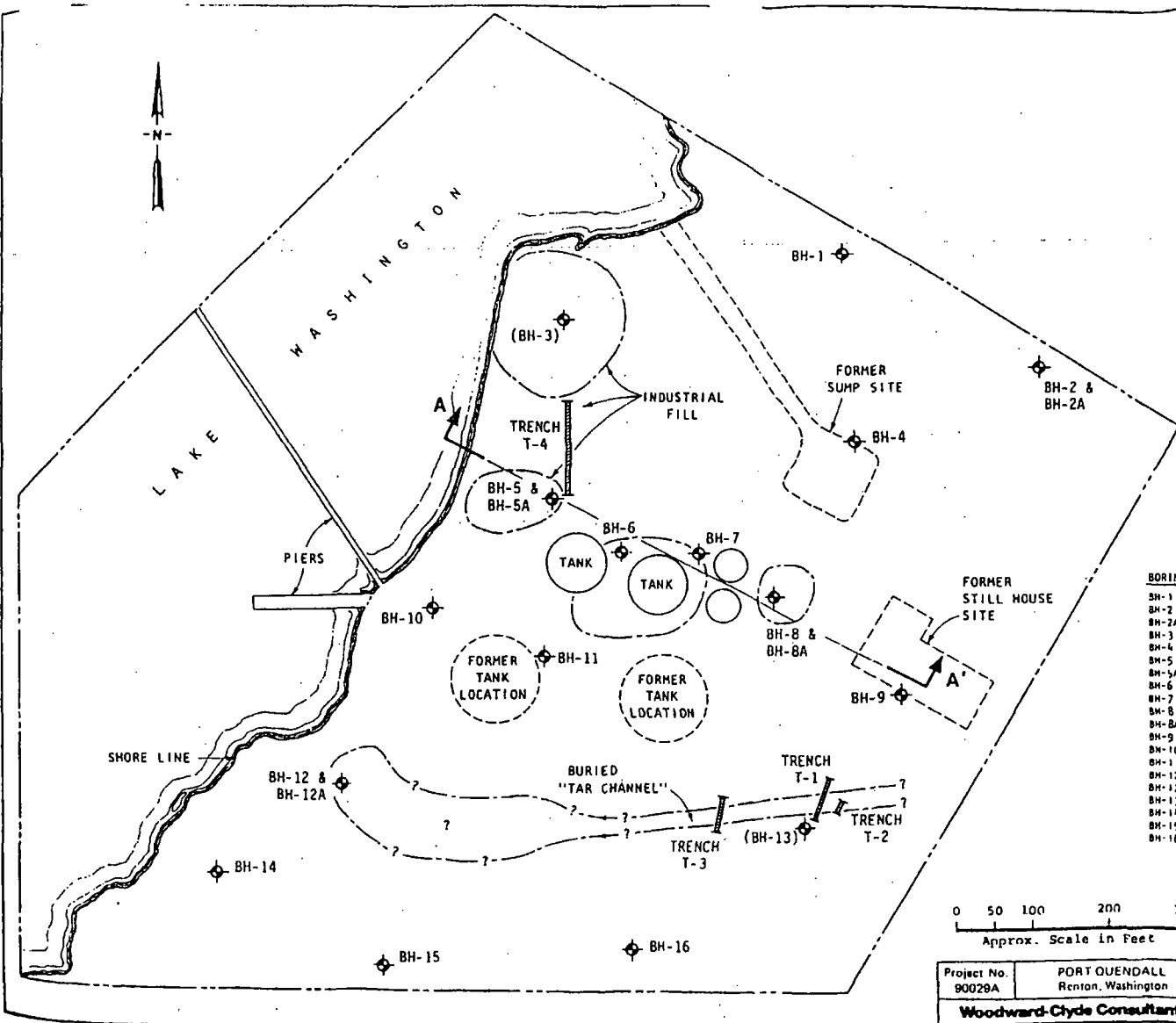
Parameter	Sample Concentration ^{a, b} ($\mu\text{g/l}$)											
	BH1	BH2	BH2A	BH5	BH5A	BH6	BH8	BH8A	BH10	BH12	BH12A	BH15
Depth Screened (feet)	5-19.5	5-19.5	5-20.0	5-10	13-23	8-18	5-10	13-23	5-19.5	5-10	13-23	5-19.5
PAH ^c	115	5.7	2640	5210	4240	930	22,700	1839	12.8	745	6.8	10.4
Benzene	L/1.0	L/1.0	L/1.0	17,000	980	94	7,000	14,000	24.0	L/1.0	L/1.0	L/1.0
Toluene	L/1.0	L/1.0	L/1.0	17,000	640	39	4,100	9,200	L/1.0	L/1.0	L/1.0	L/1.0
Xylene	2.0	L/1.0	L/1.0	17,800	490	150	5,200	4,600	5.0	L/1.0	L/1.0	6.0
Penta-chloro-phenol	L/10	L/10	L/10	--	--	--	86	--	--	--	--	--

^a L/# = Below detection level of #.

^b The sample name reflect the well from which the sample was collected.

^c $\mu\text{g/l}$ as benzo(a)pyrene, corrected for naphthalene; by Washington State Dept. of Ecology Method.





LEGEND:

- ◆ BORING LOCATION
(BH-3 & BH-13 not drilled)

BORING	NORTH	EAST	ELEVATION (GL.)	COMMENTS
BH-1	197,782	1,662,516	23.4	ft.
BH-2	197,633	1,662,767	20.8	"
BH-2A	"	"	"	5.7' W.S.V.
BH-3	197,705	1,662,150	15.6	Not drilled
BH-4	197,541	1,662,532	24.1	"
BH-5	197,473	1,662,136	23.3	"
BH-5A	"	"	"	4.5' W.
BH-6	197,406	1,662,277	20.0	"
BH-7	197,400	1,662,329	19.5	"
BH-8	197,342	1,662,426	23.4	"
BH-8A	"	"	"	6' S.
BH-9	197,214	1,662,586	25.1	"
BH-10	197,331	1,661,581	21.5	"
BH-11	197,269	1,662,126	20.5	"
BH-12	197,106	1,661,862	21.9	"
BH-12A	"	"	"	8.5' W.
BH-13	197,044	1,662,461	25.9	Not drilled
BH-14	196,993	1,661,700	19.7	"
BH-15	196,970	1,661,914	21.5	"
BH-16	196,887	1,662,737	24.4	"

0 50 100 200 300
Approx. Scale in Feet

Project No. 90028A	PORT QUENDALL Renton, Washington	BORING AND TRENCH LOCATIONS	Figure 2
Woodward-Clyde Consultants			

APPENDIX A
BORING AND WATER WELL LOGS

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Project: PORT QUENDALL
Renton, Washington

Log of Boring No. 1

Date Drilled May 17, 1983
Type of Boring 4" Hollow Stem Auger
Hammer Weight

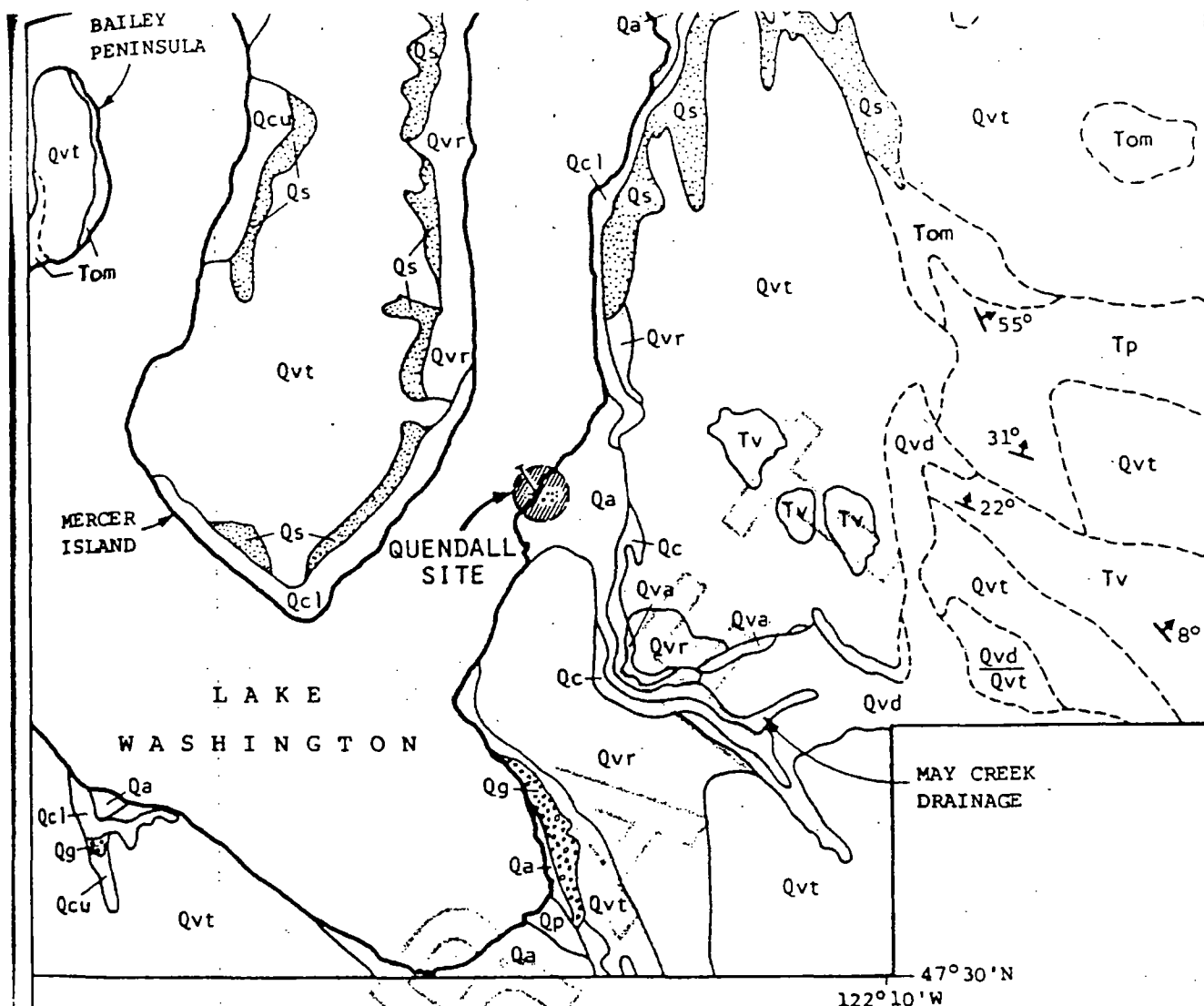
Remarks

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation: 23.4						
1			0.002	FILL Woodchips and Aggregate		
2	56	0.93		SANDY SILT (ML) Olive-gray, occasional gravel lenses, distinctive HC odor throughout		
5	3	24	4.8	↓ Becomes less sandy		
4	8	0.002		Water } With some organic debris		2-inch I.D. PVC blank
5	14	0.001		SILTY SAND (SM) Medium to fine, 20% silt, frequent peat lenses, some distinctive odor		
10				Peat lens		
6	27	0.004		Peat lens		2-inch I.D. PVC Slotted
15						
7	25	0.009		Peat lens		
20				↓ BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

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Appendix A-1



EXPLANATION

RECENT	Qa	SEDIMENTARY DEPOSITS, UNDIFFERENTIATED	Qp	PEAT
	Qvr	RECESSIONAL STRATIFIED DRIFT	Qvd	DELTA GRAVEL
	Qvt	TILL		
	Qva	ADVANCE STRATIFIED DRIFT		
PLEISTOCENE	Qs	UNNAMED SAND		
	Qcu	UPPER CLAY UNIT		
	Qg	UNNAMED GRAVEL		
	Qcl	LOWER CLAY UNIT	Qc	CLAY, UNDIFFERENTIATED
OLIGOCENE-MIOCENE	Tom	MARINE SEDIMENTARY ROCKS		
			22°	STRIKE & DIP OF CONSOLIDATED BEDS
EOCENE	Tp	PUGET GROUP		
	Tv	VOLCANIC ROCKS		

Map after Liesch, Price, & Walters

Scale: 1:48,000

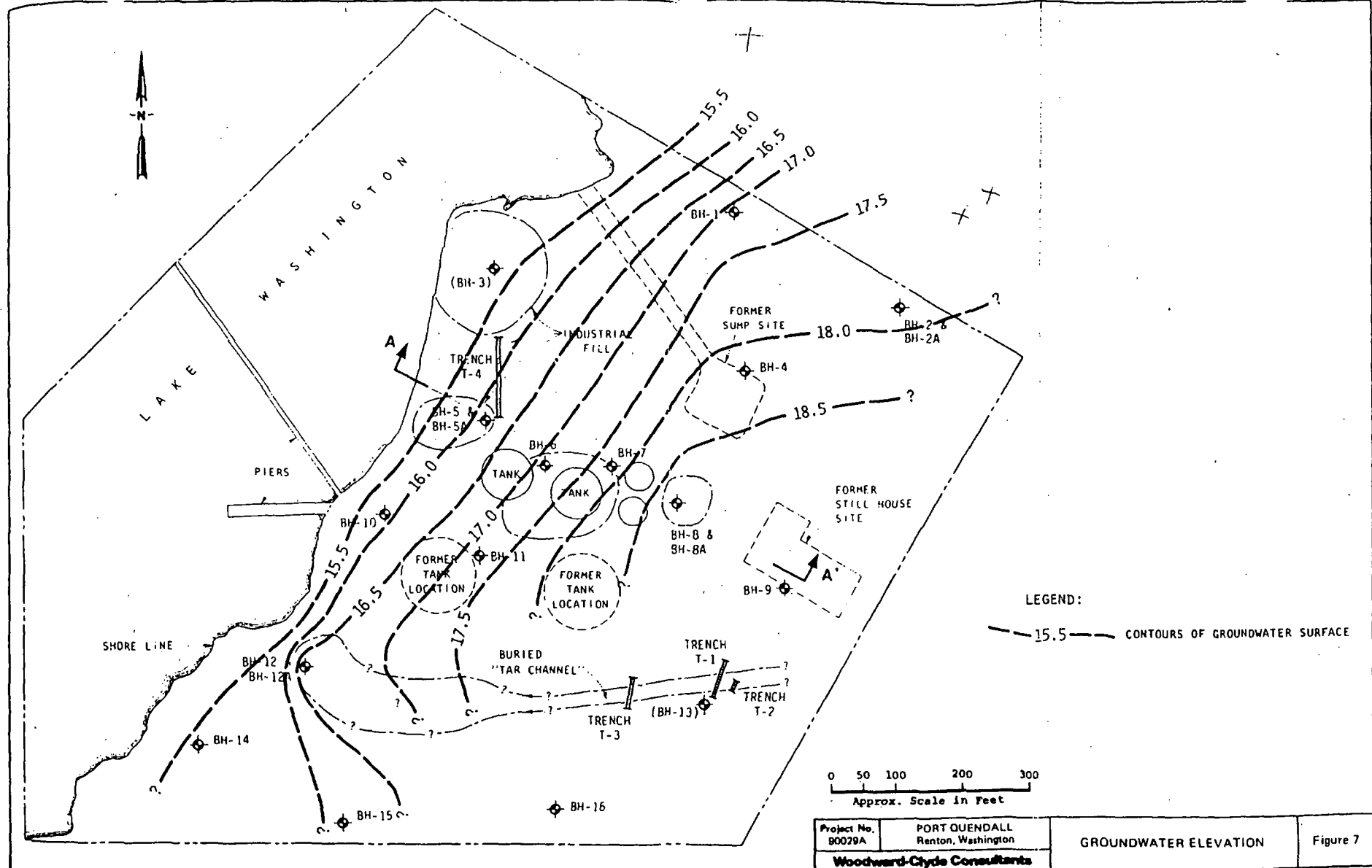
Project No.
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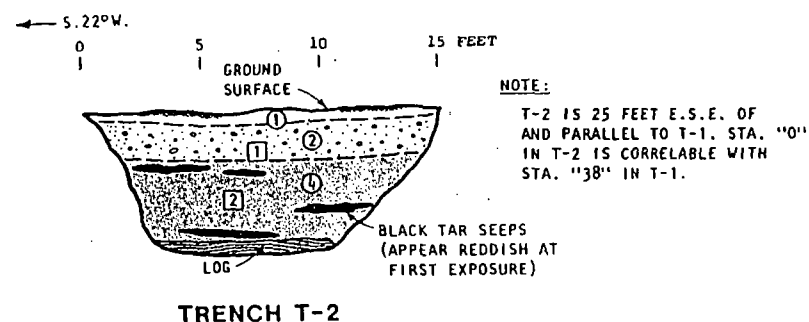
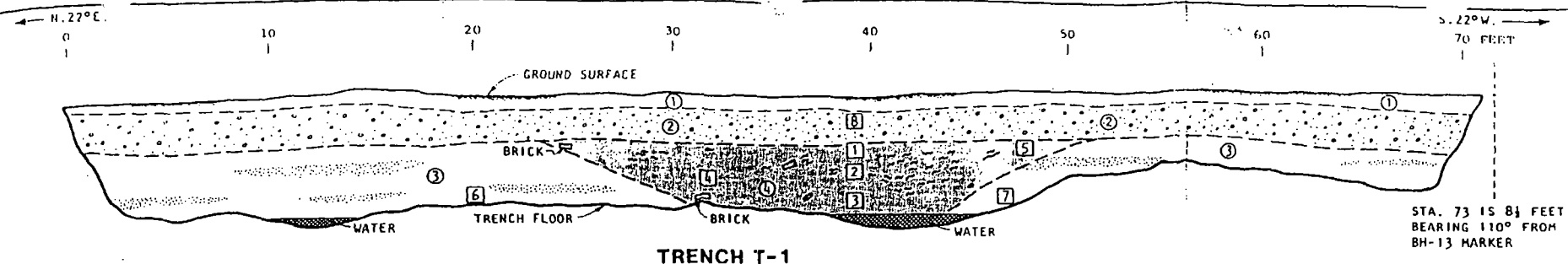
PORT QUENDALL
Renton, Washington

SURFICIAL GEOLOGY MAP

Figure 6

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UNIT DESCRIPTIONS FOR T-1 & T-2

- ① ORGANIC SILT (MH): Dark brown to black, highly plastic with abundant fibre debris (wood).
- ② SANDY GRAVEL (GP): Light brown to buff; 1" minus rounded gravel & sand aggregate fill. Wood fibre along lower contact.
- ③ SILTY SAND TO SANDY SILT (SM-ML): Gray to brown, damp, medium to fine sand, occasional coarse lenses.
- ④ CHANNEL DEPOSITS: Mottled clay, sand and gravel lenses interspersed with cultural debris including tar, bricks & wood.



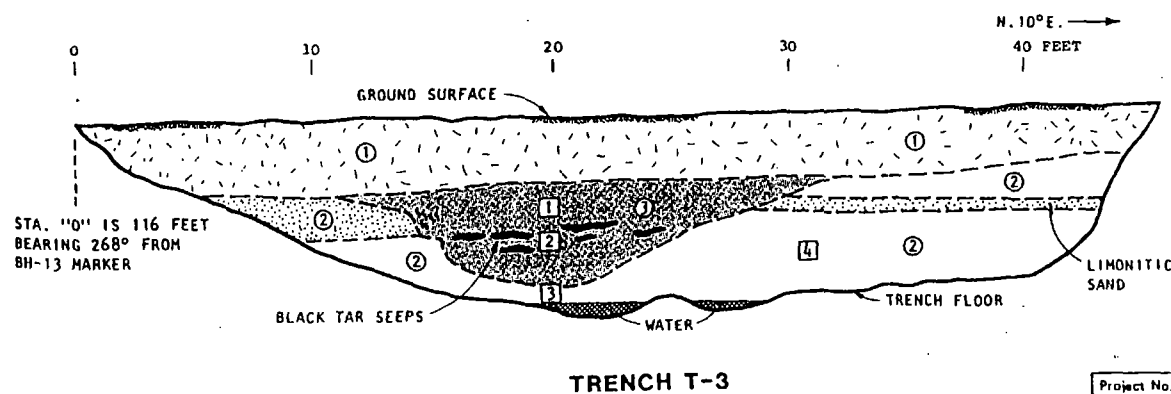
TAR FRAGMENTS



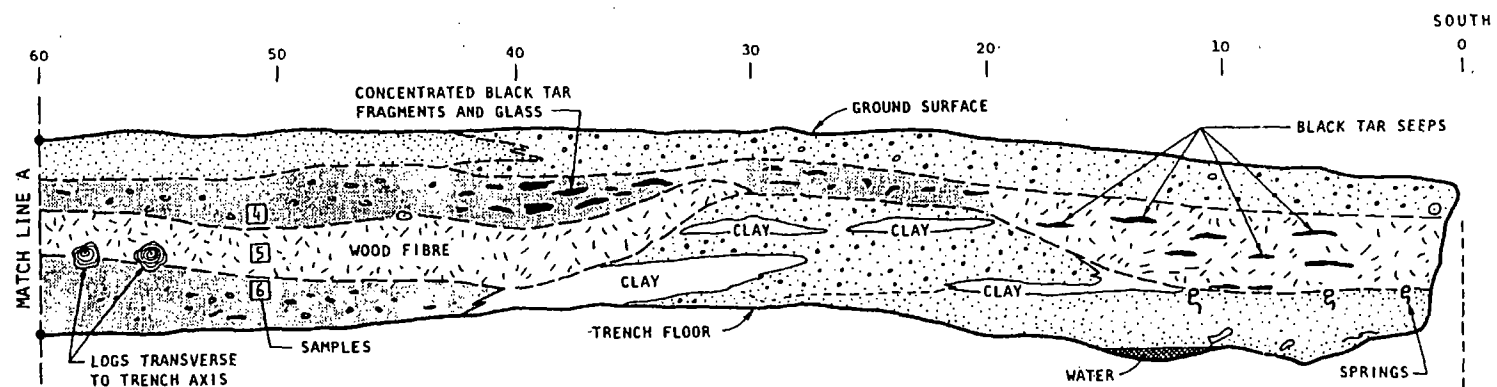
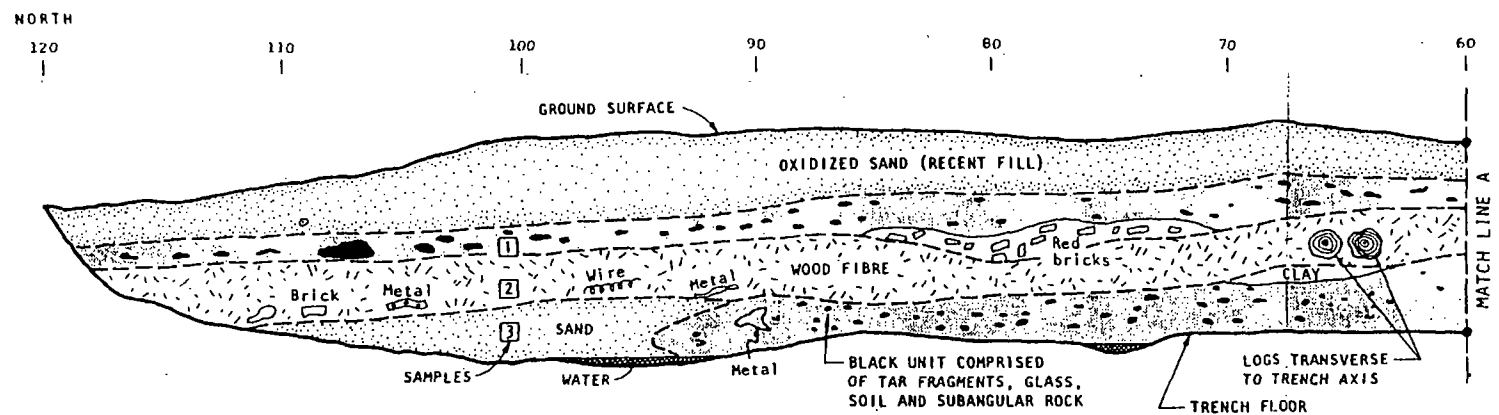
SAMPLE LOCATION AND NUMBER

UNIT DESCRIPTIONS FOR T-3

- ① FILL: Clayey organic silt, black, abundant wood fibre and rootlets.
- ② SILTY SAND TO CLAYEY SAND (SM-SP): Olive brown to gray, occasional continuous thin sand beds.
- ③ CHANNEL DEPOSITS: Abundant cultural debris including metal & tar fragments, wood, and tar seeps. Pronounced offensive odor with iridescent sheen on groundwater surface.
- ④ SAMPLE LOCATION AND NUMBER

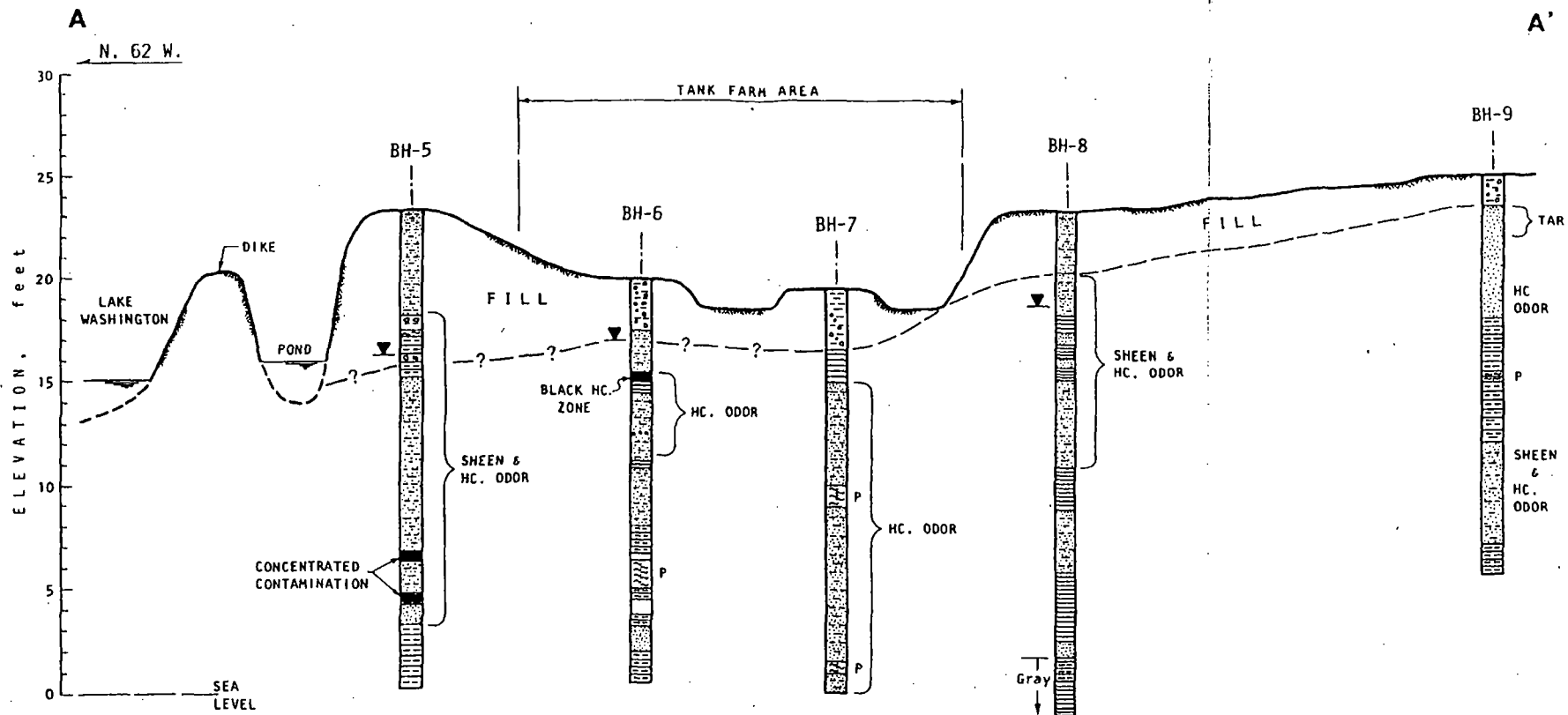


Project No. 90028A	PORT QUENDALL Renton, Washington	CROSS-SECTIONS OF TRENCHES T-1, T-2, AND T-3	Figure 3
Woodward-Clyde Consultants			



TRENCH T-4

Project No. 90029A	PORT QUENDALL Renton, Washington	CROSS-SECTION OF TRENCH T-4	Figure 4
Woodward-Clyde Consultants			



EXPLANATION

--- CONTACT LOCATION (APPROXIMATE)

▼ WATER LEVEL IN BOREHOLE

CLAY

GRAVEL

SILT

PEAT

SAND

BH-7 BORING NUMBER

HC. HYDROCARBON

NOTE: Refer to Figure 2 for location of cross-section.

0 50 100 150

Approx. Scale in Feet

Vertical Exaggeration: 10X

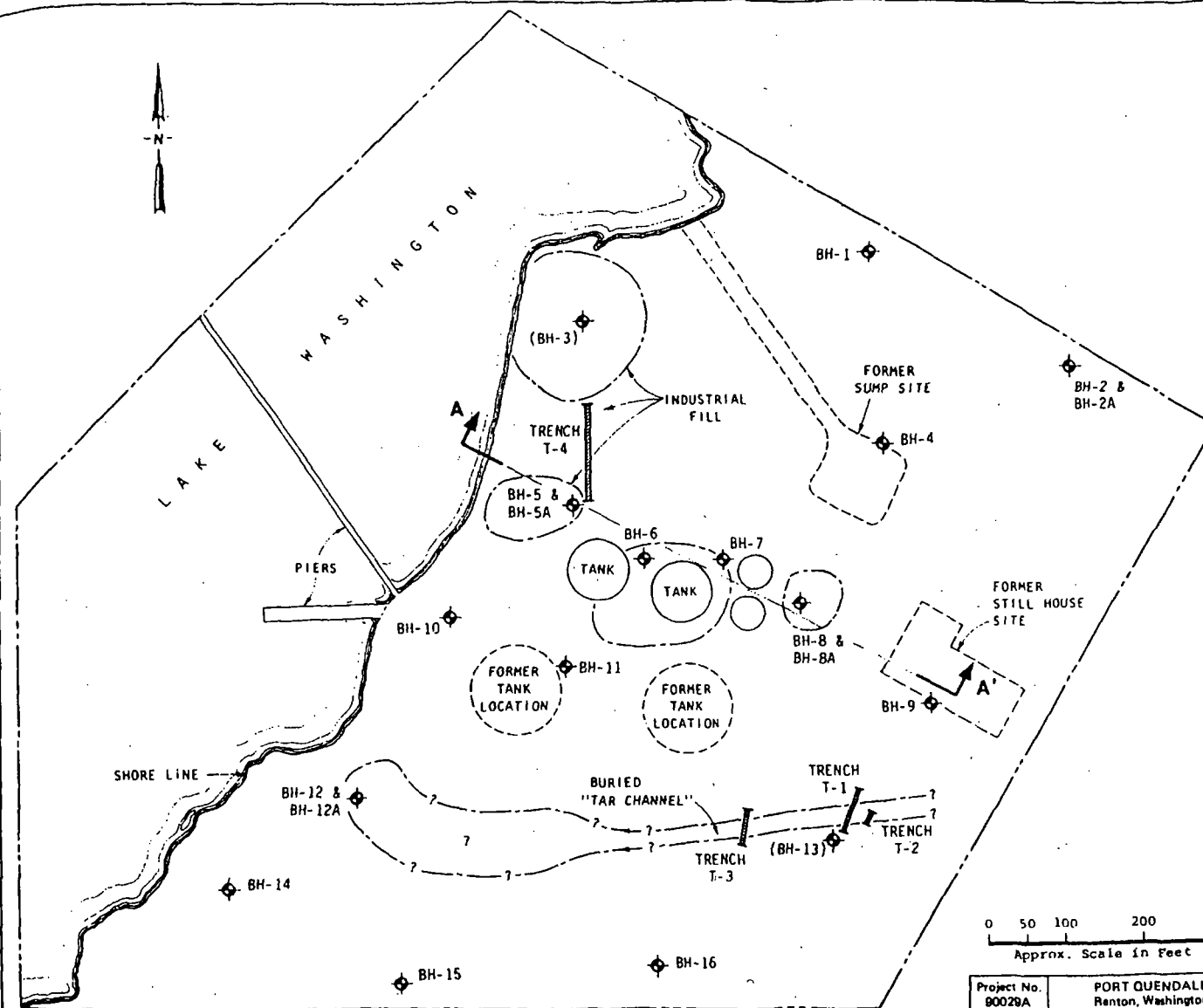
Project No.
90029A

PORT QUENDALL
Renton, Washington

GEOLOGIC CROSS-SECTION

Figure 5

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EXPLANATION

(PAH - %) : SOIL

PAH(ft.) - ppb : WATER

BORING	CONCENTRATION
BH-1	(PAH - 4.8%) PAH(5-19.5') - 115 ppb
BH-2 & BH-2A	(PAH - 0.003%) PAH(5-19') - 5.7 ppb PAH(5-20') - 2640 ppb
BH-4	(PAH - 3.4%)
BH-5 & BH-5A	(PAH - 1.9%) PAH(5-10') - 5210 ppb PAH(13-23') - 4240 ppb
BH-6	(PAH - 1.0%) PAH(8-18') - 930 ppb
BH-7	(PAH - 0.97%)
BH-8 & BH-8A	(PAH - 1.8%) PAH(5-10') - 22,700 ppb PAH(13-23') - 1839 ppb
BH-9	(PAH - 2.7%)
BH-10	(PAH - 0.63%) PAH(5-19.5') - 12.8 ppb
BH-11	(PAH - 0.017%)
BH-12 & BH-12A	(PAH - 0.004%) PAH(5-10') - 745 ppb PAH(13-23') - 6.8 ppb
BH-14	(PAH - 0.022%)
BH-15	(PAH - 0.008%) PAH(5-19.5') - 10.4 ppb
BH-16	(PAH - 1.1%)
TRENCH T-1	(PAH - 1.3%)
TRENCH T-2	(PAH - 0.50%)
TRENCH T-3	(PAH - 1.2%)
TRENCH T-4	(PAH - 1.9%)

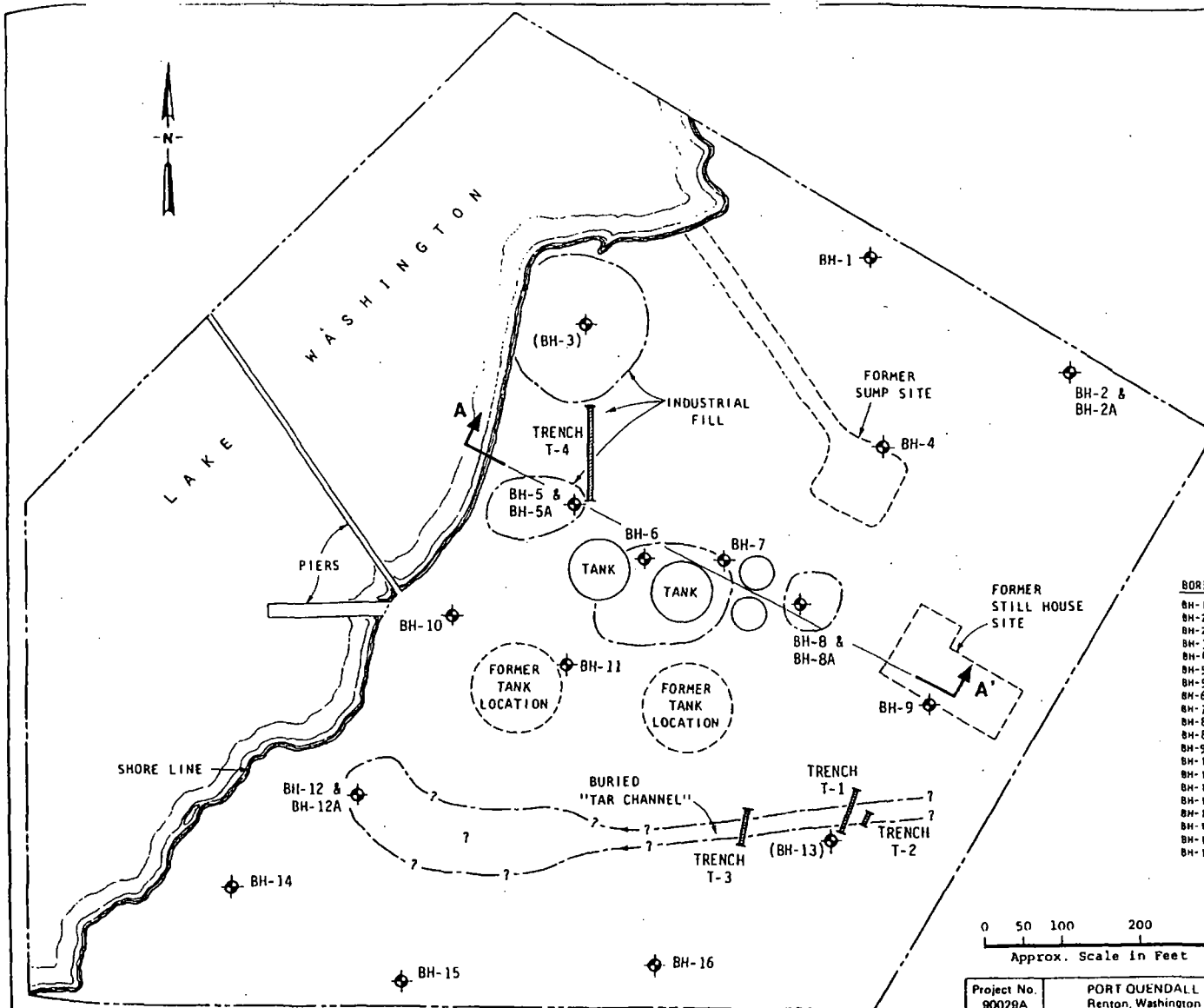
Project No.
90029A

PORT QUENDALL
Renton, Washington

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CHEMICAL CONCENTRATIONS IN
SOIL AND WATER

Figure B



LEGEND:

- ◆ BORING LOCATION
(BH-3 & BH-13 not drilled)

BORING	NORTH	EAST	ELEVATION (GL.)	COMMENTS
BH-1	197,782	1,662,516	23.4	ft.
BH-2	197,633	1,662,767	20.8	"
BH-2A	"	"	"	5.7' W.S.V.
BH-3	197,705	1,662,150	15.6	" Not drilled
BH-4	197,541	1,662,532	24.1	"
BH-5	197,473	1,662,136	23.3	"
BH-5A	"	"	"	4.5' W.
BH-6	197,406	1,662,227	20.0	"
BH-7	197,400	1,662,329	19.5	"
BH-8	197,342	1,662,426	23.4	"
BH-8A	"	"	"	6' S.
BH-9	197,214	1,662,586	25.1	"
BH-10	197,331	1,661,981	21.5	"
BH-11	197,269	1,662,126	20.5	"
BH-12	197,106	1,661,862	21.9	"
BH-12A	"	"	"	6.5' W.
BH-13	197,044	1,662,461	25.9	" Not drilled
BH-14	196,993	1,661,700	19.7	"
BH-15	196,970	1,661,914	21.9	"
BH-16	196,887	1,662,237	24.4	"

0 50 100 200 300
Approx. Scale in Feet

Project No. 90029A	PORT QUENDALL Renton, Washington	BORING AND TRENCH LOCATIONS	Figure 2
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Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 2

Date Drilled May 17, 1983

Remarks

Type of Boring 4" Hollow Stem Auger

Hammer Weight

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WFIL DETAIL
Surface Elevation 20.8						
1	52	<		FILL Silt, Gravel and black organic debris		
2	33	0.002		SILTY SAND (SM) Olive-gray, damp, occasional lenticular gravels and peat interbeds		
3	8	0.003		Water ▽		
4	44	<				
5	27	<				
6	10	0.001		Peat Peat		
7	34	<		Peat		
BOTTOM OF BORING @ 19.5'						

Proj. No. 90029A

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Appendix A-2

Project: PORT QUENDALL Renton, Washington				Log of Boring No. 4	
Date Drilled: May 18, 1983				Remarks: _____	
Type of Boring: 4" Hollow Stem Auger				_____	
Hammer Weight: _____				_____	

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation: _____						
1		26	<	FILL Silt with aggregate		
5	2			SANDY SILT (ML) Dark brown, occasional peat lenses } Log ↑ FILL		
10	3	2	0.056	CLAYEY SILT (MH) Black, medium-highly plastic, noticeable HC odor and iridescent sheen, some peat Iridescent throughout		Bentonite plug 0-23'
4	18		0.44			
5	4		3.4			
15				CLAY (CH) Brown, with occasional peat lenses		
6	7		0.75			
20				BOTTOM OF BORING @ 23'		
7	2		0.041			

DRAFT

Proj. No. 90029A

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Appendix A-4

Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 5

Date Drilled: May 20, 1983

Remarks

Type of Boring 6" Hollow Stem Auger

Hammer Weight

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation						
1		10	0.73	FILL Silty Sand (SM), brown, dry, some organic debris/rootlets		
2		10	1.0			
3		16	0.90			
4		20	0.89	Becomes damp, pitch fragments and black fibres, with noticeable HC odor.		
5		24	0.89	SILTY CLAY (CH-CL) Olive-gray, medium to high plasticity, occasional black fibres & brick fragments		
6		34	0.006			
10				SILTY SAND (SM) Gray, medium to coarse, distinctive HC odor and iridescent sheen		
7		29	0.006			
15				Concentrated contamination Noticeable HC odor and iridescent sheen; some rapid corporation of lighter fractions noted		
8		28	1.9	Concentrated contamination		
20				CLAYEY SILT to SANDY SILT (MH-ML) Brown, some odor		
9		12	0.71			
				BOTTOM OF BORING @ 23'		

Proj. No. 90029A

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Appendix A-5

Appendix A-6

Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 6

Date Drilled May 20, 1983

Remarks:

Type of Boring 6" Hollow Stem Auger

Hammer Weight:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation:						
				FILL Silt and aggregate push for drill pad		
1	6	1.0				
5	2	48	0.023	Black HC zone, distinctive odor		4-inch I.D. PVC blank
3	7	0.94		SILTY SAND (SM) Gray, medium to coarse, occasional clay lenses, noticeable HC odor		
4	16	0.01				
10						
5	8	0.002		SILTY CLAY (CH-CL) Brown, occasional peat lenses		4-inch I.D. PVC slotted
15						
6	3	0.001				
20				BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

Woodward-Clyde Consultants

Appendix A-7

Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 7

Date Drilled May 17, 1983

Remarks

Type of Boring 4" Hollow Stem Auger

Hammer Weight

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation:						
				FILL Silt with gravel, silt pushed for drill pad ↓ With gravel		
1	11	0.91		CLAY (CH) Olive-gray, highly plastic, damp		
5	2	0.081		SANDY SILT (ML) Dark gray, noticeable HC odor and iridescence		
3	3	0.74				
4	1.5	0.97				
10	5	0.88		PEAT: With clay, brown, highly plastic, noticeable HC odor		
				SILTY SAND (SM) Dark gray, medium to coarse, noticeable HC odor, occasional peat lenses		
6	34	0.001				
15						
				← Peat interbed With HC odor		
7	44	0.008				
20				← BOTTOM OF BORING @ 19.5'		

Bentonite plug 0-19.5'

Proj. No. 90029A

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Appendix A-8

Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 8

Date Drilled May 19, 1983

Remarks

Type of Boring 6" Hollow Stem Auger

Hammer Weight

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation						
1		36	0.86	FILL Sandy Silt (ML), dark brown, damp		
2		53	0.054			
3			0.013	SILTY SAND (SM) Olive-gray, medium grained, distinctive HC odor and iridescent sheen		
4		19	0.94	CLAY (CH): Light gray, highly plastic		
5		44	1.2	SAND (SW): Black, HC odor and sheen		
6		30	1.1	CLAY (CH): Light gray		
				CLAY (CH): Brown		
10				Water SILTY SAND (SM) Gray, 30% silt, noticeable HC odor and abundant brown fluid and iridescent sheen		4-inch I.D. PVC blank
15				SILTY CLAY (CH-CL) Light brown, highly plastic, some organic debris (wood)		
				SILTY SAND (SM) Brownish gray, 30% sand		
8		19	1.3	SILTY CLAY (CH-CL) Dark brown, occasional sand lenses		4-inch I.D. PVC slotted
20				Becomes gray		
22						
24	9	27	0.042	BOTTOM OF BORING @ 24.5'		

Proj. No. 90029A

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Appendix A-9

Project: PORT QUENDALL Renton, Washington				Log of Boring No. 9	
Date Drilled: May 16, 1983				Remarks: _____	
Type of Boring: 4" Hollow Stem Auger				_____	
Hammer Weight: _____				_____	

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation: _____						
1			0.005	FILL Silt, with some gravels		
2			1.7	TAR: Black, distinctive HC odor, with occasional cement fragments		
3			2.2	SAND: Black stain with odor — Wood		
4	10		1.3			
5	4		0.014	CLAYEY SILT (MH) Olive-gray, damp, soft, distinctive odor		
6	9		1.0	Brown peat		
7	25		0.03	SILTY SAND (SM) Medium to fine, poorly sorted, distinctive iridescent sheen and odor in sand		
8	28		<	CLAYEY SILT (MH) Olive-gray, slight odor		
20				BOTTOM OF BORING @ 19.5		

Proj. No. 90029A	Woodward-Clyde Consultants	Appendix A-11
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Project:

PORT QUENDALL
Renton, Washington

Log of Boring No. 10

Date Drilled

May 18, 1983

Remarks:

Type of Boring:

6" Hollow Stem Auger

Hammer Weight:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation.						
1		20	0.63	FILL Silty Sand (SM), olive-brown, 10% silt, occasional organic debris and gravels Water ↓ Becomes gray, with slight HC odor		
2		28	0.009			
3		19	0.002			
4		22	0.002			
5		11	0.002			
6		9	<	CLAYEY SILT (MH) Brown, 20-30% clay, highly plastic, damp		
7		15	<	SILTY SAND (SM)		
20				BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

Woodward-Clyde Consultants

Appendix A-12

Project: PORT QUENDALL
Renton, Washington

Log of Boring No. 11

Date Drilled: May 18, 1983
Type of Boring: 4" Hollow Stem Auger
Hammer Weight:

Remarks:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation						
1	14	0.007		FILL Gravel and Sand		
2	66	0.017		SANDY SILT (ML) Dark brown, 20-40% sand, some clay, occasional lenticular gravels and peat		
3	36	0.002				
5	4	6	0.002	→ Brown peat		
5	13	0.003		CLAYEY SILT (MH) Gray, soft, dry, some organic debris, and peat interbeds		
6	25	0.003		SILTY SAND (SM) Dark gray, 30% silt, no odor (occasional peat lenses)		
10				→ Thin (0.2') peat lens		
7	16	<		→ Thin (0.2') peat lens		
15				→ Thin (0.2') peat lens		
8	27	0.01				
20				→ BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

Woodward-Clyde Consultants

Appendix A-13

Project: PORT QUENDALL
Renton, Washington

Log of Boring No. 12

Date Drilled: May 17, 1983

Remarks

Type of Boring: 4" Hollow Stem Auger

Hammer Weight:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation:						
				FILL: Silt, dark brown		
				FILL: Silt, with organics		
1	29	0.004		SILTY SAND (SM) Gray, medium to fine, occasional gravel lenses, and organic		
2	20	<				
5	3	53	0.001			
4	40	0.003		SANDY SILT / CLAYEY SILT (ML-MH) Brown, damp, soft, abundant organic debris		
10						
5	19	0.001		SILTY SAND (SM) Gray, 40% silt, abundant organic debris		
15						
6	4	0.003		SILTY CLAY (CH-CL) Brown, damp, medium to highly plastic		
20						
7	2	<		BOTTOM OF BORING @ 23'		

Proj. No. 90029A

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Appendix A-14

Project: PORT QUENDALL Renton, Washington				Log of Boring No. 12A			
Date Drilled: _____				Remarks: _____			
Type of Boring: 6" Hollow Stem Auger				_____			
Hammer Weight: _____				_____			
Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL	
Surface Elevation: _____							
<div style="text-align: center;">5</div> <div style="text-align: center;">10</div> <div style="text-align: center;">15</div> <div style="text-align: center;">20</div>				<p>MONITORING WELL 12A "AS BUILT" DIAGRAM</p> <p>No lithologic log or sampling</p> <p>Installation is shallow monitoring well 6.5 feet west of Boring 12</p>			
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Project: PORT QUENDALL
Renton, Washington

Log of Boring No. 14

Date Drilled: May 18, 1983
Type of Boring: 4" Hollow Stem Auger
Hammer Weight:

Remarks:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation:						
1			0.022	FILL Silt and Gravel Aggregate, slight odor, occasional pitch fragments and wood		
2		43	0.007	Pitch fragments Water		
3		26	0.007			
4		28	<			
5		20	0.009	SILTY SAND (SM) Dark gray, medium, saturated, occasional thin gravel interbeds		
6		7	<	Grades to finer sand Becomes fine sand		
7		24	<	Coarse		
				PEAT With clay, brown, highly plastic		
				BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

Woodward-Clyde Consultants

Appendix A-16

Project: PORT QUENDALL
Renton, Washington

Log of Boring No. 15

Date Drilled: May 17, 1983

Remarks

Type of Boring: 4" Hollow Stem Auger

Hammer Weight:

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation						
1	58	0.004		FILL: Silt, dark brown		
				SAND (SW) Medium to fine, occasional gravel and clay lenses, slight HC odor		
2	32	0.008				
				SANDY SILT (ML) Greenish gray, some clay (co-20%) occasional organics/peat fragments		
3	22	0.002				
4	44	<				
5	43	<		SILTY SAND (SP-SM) 30% silt, medium to coarse sand, some HC odor throughout		
6	19	0.002		PEAT: With clay, brown, highly plastic		
7	9	0.001		SILTY SAND (SP-SM) Slight odor		
				BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A

Woodward-Clyde Consultants

Appendix A-17

Project: PORT QUENDALL Renton, Washington				Log of Boring No. 16	
Date Drilled: May 16, 1983				Remarks:	
Type of Boring: 4" Hollow Stem Auger					
Hammer Weight:					

Depth, Ft	Samples	Blows/Ft	PAH concentration (%)	MATERIAL DESCRIPTION	LITHOLOGY	WELL DETAIL
Surface Elevation:						
1	79	0.004		FILL	[Symbol]	
2	54	1.1		SAND (SW) Medium, occasional gravel lenses, noticeable HC odor and black stain	[Symbol]	
3	19	0.001		SAND (SP) Medium to coarse, occasional gravel lenses, no stain or odor	[Symbol]	
4	8	<		Water ▽	[Symbol]	
5	32	<		CLAYEY SILT (MH) Olive-gray, medium plasticity, occasional organics, (brownish peat lenses)	[Symbol]	
6	19	<			[Symbol]	
7	32	<		Peat lens	[Symbol]	
8	29	<		Clayey silt lens	[Symbol]	
9	18	<		SAND (SW) Dark gray, some silt	[Symbol]	
				CLAY (CH): Stiff	[Symbol]	
				BOTTOM OF BORING @ 19.5'		

Proj. No. 90029A	Woodward-Clyde Consultants	Appendix A-18
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APPENDIX B

FIELD WATER SAMPLING AND WATER LEVEL DATA SHEETS

DRAFT

FIELD WATER SAMPLING DATA SHEET

Port Quendall- Project 90029 A

Don W. Spencer- Project Geologist

[illegible]

FIELD WATER SAMPLING DATA SHEET
Port Quendall- Project 90029 A
Don W. Spencer- Project Geologist

[illegible]

FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	Ca	SAMPLE #	REMARKS
BH2A	6-29-83	9:10	—	7.17	12.5	5.9	472mbars	1	START Pump
"	"	9:23	13.75	10.16	15	6.3	412 "	2	Pump on
"	"	9:37	27.5	10.24	15	6.3	420 "	3	" "
"	"	9:55	41.25	10.25	15	6.3	438 "	4	" "
"	"	10:12	55	10.26	15	6.0	447 "	5	" "
"	"	10:26	68.17	10.56	15	6.1	450 "	6	" "
"	"	10:38	82.5	10.71	15	5.7	444 "	7	" "
"	"	10:53	96.2	10.65	15	6.2	462 "	8	" "
"	"	11:04	110	11.6?	15.5	6.1	454 "	9	" "
"	"	11:17	123.7	11.46	15	6.1	467 "	10	" "
"	"	11:29	137.5	11.61	15	6.1	453 "	11	" "
"	"	11:40	151.2	11.70	15	5.9	467 "	12	" "
"	"	11:53	165.5	11.63	15	5.7	472 "	13	" "
"	"	11:56	—	11.64	—	—	—	—	Stop Pump
"	"	11:56:30	—	10.91	—	—	—	—	Recovery
"	"	11:57	—	10.3	—	—	—	—	" "
"	"	11:57:30	—	9.81	—	—	—	—	" "
"	"	11:58	—	9.54	—	—	—	—	" "
"	"	11:58:30	—	9.30	—	—	—	—	" "
"	"	11:59	—	9.09	—	—	—	—	" "
"	"	12:00	—	8.72	—	—	—	—	" "
"	"	12:01	—	8.49	—	—	—	—	" "
"	"	12:03	—	8.19	—	—	—	—	" "
"	"	12:05	—	8.03	—	—	—	—	" "
"	"	12:08	—	7.88	—	—	—	—	" "

FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	Ca	SAMPLE #	REMARKS
34-5	6-17-83	12:48	—	9.36	13	5.9	705	1	START Pump
"	"	13:02	13.75	10.29	15	5.8	732	2	Flowing
"	"	13:16	27.5	10.54	15.5	5.7	755	3	"
"	"	13:29	41.25	10.64	15	5.7	782	4	"
"	"	13:38	55.0	10.81	15	5.7	806	5	"
"	"	13:47	63.7	11.00	15	5.8	847	6	"
"	"	13:58	82.5	11.05	15	5.7	844	7	"
"	"	14:08	96.25	11.20	14	5.7	834	8	"
"	"	14:16	110	11.36	14	5.7	837	9	"
"	"	14:25	123.7	11.25	14	5.7	841	10	"
"	"	14:34	137.5	11.28	14	5.8	836	11	"
"	"	14:44	151.2	11.22	14	5.8	717	12	"
"	"	14:53	165	11.31	14	5.8	852	13	"
"	"	14:56	—	—	—	—	—	—	STOP Pump
"	"	14:56:30	—	10.33	—	—	—	—	Recovery
"	"	14:57	—	10.11	—	—	—	—	"
"	"	14:57:30	—	9.96	—	—	—	—	"
"	"	14:58	—	9.88	—	—	—	—	"
"	"	14:59	—	9.84	—	—	—	—	"
"	"	15:00	—	9.78	—	—	—	—	"
"	"	15:02	—	9.75	—	—	—	—	"

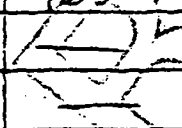

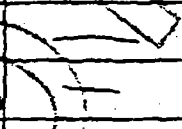
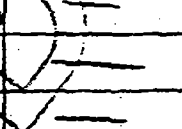
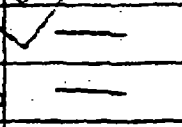
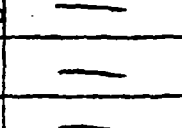
Don W. Spencer- Project Geologist

* Well produced an average of 0.1 to 0.28 GPM which reduced pump's working time to achieve desired cumulative volume. Sampling followed recovery period. Black tar residue on boiler suggests that reduced productivity may be the result of severe blockage in the well by mobile tar.

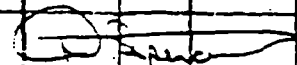
FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	CS	SAMPLE #	REMARKS
BH-6	6-17-82	16:01	—	4.67	14	5.5	305.5m	1	Start Pump
"	"	16:08	13.75	6.82	14	5.4	336 "	2	Pumping
"	"	16:15	27.5	6.98	14	5.4	344 "	3	" "
"	"	16:21	41.25	7.93	14	5.5	337 "	4	" "
"	"	16:26	55.0	8.13	14	5.5	339 "	5	" "
"	"	16:31	68.17	8.10	14	5.4	344 "	6	" "
"	"	16:36	82.5	8.14	14	5.4	342 "	7	" "
"	"	16:40	96.2	8.18	14	5.4	339 "	8	" "
"	"	16:45	110	8.17	14	5.7	341 "	9	" "
"	"	16:49	123.7	8.43	14	5.7	340 "	10	" "
"	"	16:53	137.5	8.62	14	5.7	342 "	11	" "
"	"	16:58	151.2	8.64	14	5.6	340 "	12	" "
"	"	17:02	165	8.68	14	5.6	338 "	13	" "
"	"	17:04	—	8.70	—	—	—	—	Stop Pump
"	"	17:04:30	—	8.10	—	—	—	—	Recovery
"	"	17:05	—	6.54	—	—	—	—	" "
"	"	17:05:30	—	6.27	—	—	—	—	" "
"	"	17:06	—	6.09	—	—	—	—	" "
"	"	17:07	—	5.93	—	—	—	—	" "
"	"	17:08	—	5.83	—	—	—	—	" "
"	"	17:10	—	5.67	—	—	—	—	" "
"	"	17:12	—	5.56	—	—	—	—	" "

FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	Ca	SAMPLE #	REMARKS
BH-8	6-16-83	15:28	—	6.37	15	6.3	402 umho	1	START Pump
"	"	15:52	13.75	11.88	15	6.0	501 "	2	Pumping
"	"	16:10	27.5	12.92	15	6.0	515 "	3	" "
"	"	16:24	41.25	13.17	15	5.8	520 "	4	" "
"	"	16:42	55	13.18	15	5.8	527 "	5	" "
"	"	16:55	68.7	16.38	15	5.9	512 "	6	" "
"	"	17:05	82.5	17.63	15	5.9	510 "	7	" "
"	"	17:17	96.3	18.36	15	5.8	516 "	8	TRANS- 500-1000
"	"	17:27	110	18.47	15	5.8	520 "	9	" "
"	"	17:40	123.7	19.09	15	5.8	519 "	10	" "
"	"	18:02	137.5	14.84	15	5.8	539 "	11	" "
"	"	18:21	151.2	14.33	15	5.8	538 "	12	" "
"	"	18:35	165	16.85	15	5.8	525 "	13	" "
"	"	18:38		17.0	—	—	—	—	Stop Pump
"	"	18:38:20		16.35	—	—	—	—	Recover R-1
"	"	18:25		15.75	—	—	—	—	" "
"	"	18:39:30		—	—	—	—	—	" "
"	"	18:40		—	—	—	—	—	" "
"	"	18:40:20		14.60	—	—	—	—	" "
"	"	18:41:20	—	14.25	—	—	—	—	" "
"	"	18:42	—	13.79	—	—	—	—	" "
"	"	18:43	—	13.05	—	—	—	—	" "
"	"	18:44	—	12.56	—	—	—	—	" "
"	"	18:46	—	11.56	—	—	—	—	" "
"	"	18:50	—	10.4	—	—	—	—	" "

FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist-

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	ON	SAMPLE #	REMARKS
34 BA	6-17-83	9:37	—	4.54	15.0	5.9	47.4	1	START PUMP
"	"	9:47	—	10.00	—	—	—	—	WELL DRY- STOPPED PUMP
"	"	10:07	—	4.82	—	—	—	—	START PUMP
"	"	10:50	11.4 GAL	6.42	—	62.9	67	2	
"	"	11:00	22.8 GAL	—	—	—	—	—	STOP PUMP
"	"	11:08	—	3.35	—	—	—	—	Recovery
"	"	11:09	—	8.48	—	—	—	—	"
"	"	11:09	—	3.18	—	—	—	—	"
"	"	11:09	—	7.93	—	—	—	—	"
"	"	11:10	—	7.70	—	—	—	—	"
"	"	11:11	—	7.32	—	—	—	—	"
"	"	11:12	—	7.11	—	—	—	—	"
"	"	11:13	—	6.98	—	—	—	—	"
"	"	11:15	—	6.74	—	—	—	—	"
"	"	11:17	—	6.48	—	—	—	—	"
"	"	11:20	—	6.12	—	—	—	—	"
"	"	11:40	—	—	13	62	672	3	BALING & SAMPLING
* NOTE: 22.8 GAL PUMPED PLUS due well volume bailed prior to sampling For Lab; well production low, time & budget dictated that sampling be done as scheduled.									
									

FIELD WATER SAMPLING DATA SHEET
 Port Quendall- Project 90029 A
 Don W. Spencer- Project Geologist

WELL	DATE	TIME	VOLUME OF DISCHARGE	DEPTH TO WATER	TEMP (°C)	pH	Cs	SAMPLE #	REMARKS
241b	6-15-83	9:15	0	6.65	13.0	5.6	548 unkg	1	Start Pump
"	"	9:19	3.75	10.35	13.5	5.7	512 "	2	Pumping
"	"	9:26	5.75	10.95	13.5	5.7	512 "	3	" "
"	"	9:31	6.25	11.13	13.5	5.7	512 "	4	" "
"	"	9:38	5.5	11.32	13.5	5.6	513 "	5	" "
"	"	9:43	63.7	11.48	13.5	5.7	507 "	6	" "
"	"	9:51	12.5	11.62	14.0	5.7	505 "	7	" "
"	"	9:58	26.25	11.75	14.0	5.7	510 "	8	" "
"	"	10:02	10	11.85	14.0	5.7	506 "	9	" "
"	"	10:12	123.7	11.96	14.0	5.6	499 "	10	" "
"	"	10:15	137.5	12.02	14.0	5.6	510 "	11	" "
"	"	10:22	151.2	12.18	14.0	5.6	501 "	12	" "
"	"	10:27	165	12.22	14.0	5.6	502 "	13	" "
"	"	10:28		10.35	—	—	—	—	Stop Pump
"	"	10:29		10.35	—	—	—	—	Recovery
"	"	10:30		9.58	—	—	—	—	" "
"	"	10:30:30		9.17	—	—	—	—	" "
"	"	10:30:50		8.80	—	—	—	—	" "
"	"	10:31		8.54	—	—	—	—	" "
"	"	10:31:20		8.32	—	—	—	—	" "
"	"	10:32		8.18	—	—	—	—	" "
"	"	10:33		7.94	—	—	—	—	" "
"	"	10:34		7.8	—	—	—	—	" "
"	"	10:35		—	—	—	—	—	BEGIN HAND BAILING
"	"	11:00		—	—	—	—	—	END HAND BAILING

Don W. Spencer- Project Geologist

WELL WAS PUMPED ON 6-15-83 WITH INSUFFICIENT PRODUCTION TO SUSTAIN PUMP. SUBSEQUENT DAILING ON 6-20-83 AT 3 VOLUMES PERMITTED DATA WHICH APPEARS ABOVE

Don W. Spencer- Project Geologist

[illegible]

WATER LEVEL DATA SHEET

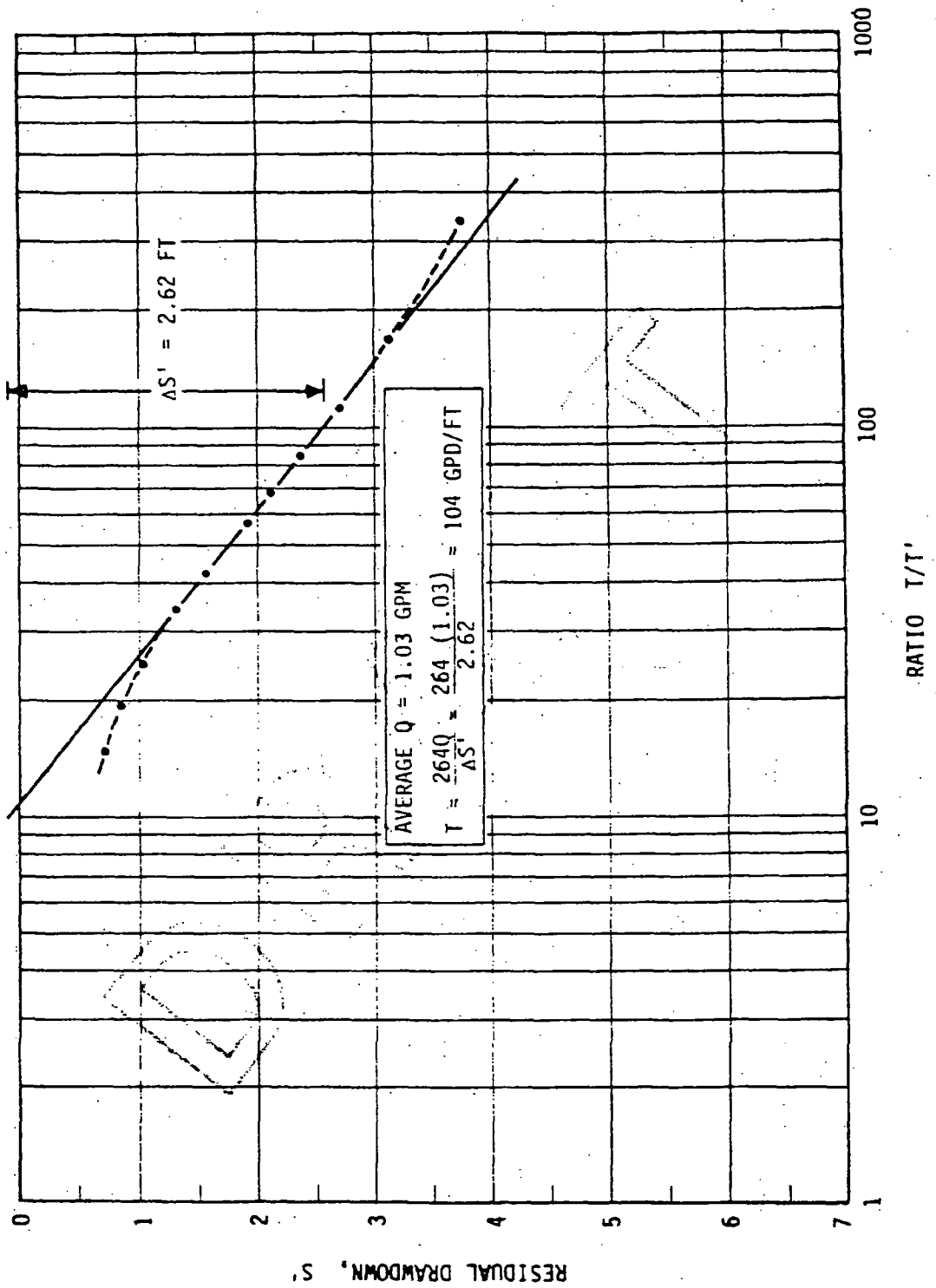
WELL	DATE	TIME	MEASURING POINT (MP)	MP ELEVATION (FT)	DEPTH TO WATER (FT)	STATIC WATER ELEVATION (FT)
BH-1	6-27-83	14:15	top of casing	23.42	6.11	17.31
BH-2	6-27-83	13:59	top of casing	25.47	7.53	17.94
BH-2A	6-27-83	14:07	top of casing	25.06	7.16	17.90
BH-5	6-27-83	12:50	top of casing	25.64	9.51	16.13
BH-5A	6-27-83	13:02	top of casing	24.28	7.81	16.47
BH-6	6-27-83	12:44	top of casing	21.85	4.84	17.01
BH-8	6-27-83	13:09	top of casing	25.12	6.40	18.72
BH-8A	6-27-83	13:12	top of casing	23.64	4.72	18.92
BH-10	6-27-83	12:10	top of casing	22.50	6.59	15.91
BH-12	6-27-83	12:19	top of casing	24.39	7.56	16.83
BH-12A	6-27-83	12:23	top of casing	21.41	5.11	16.30
BH-15	6-27-83	12:31	top of casing	21.70	5.55	16.15

DRAFT

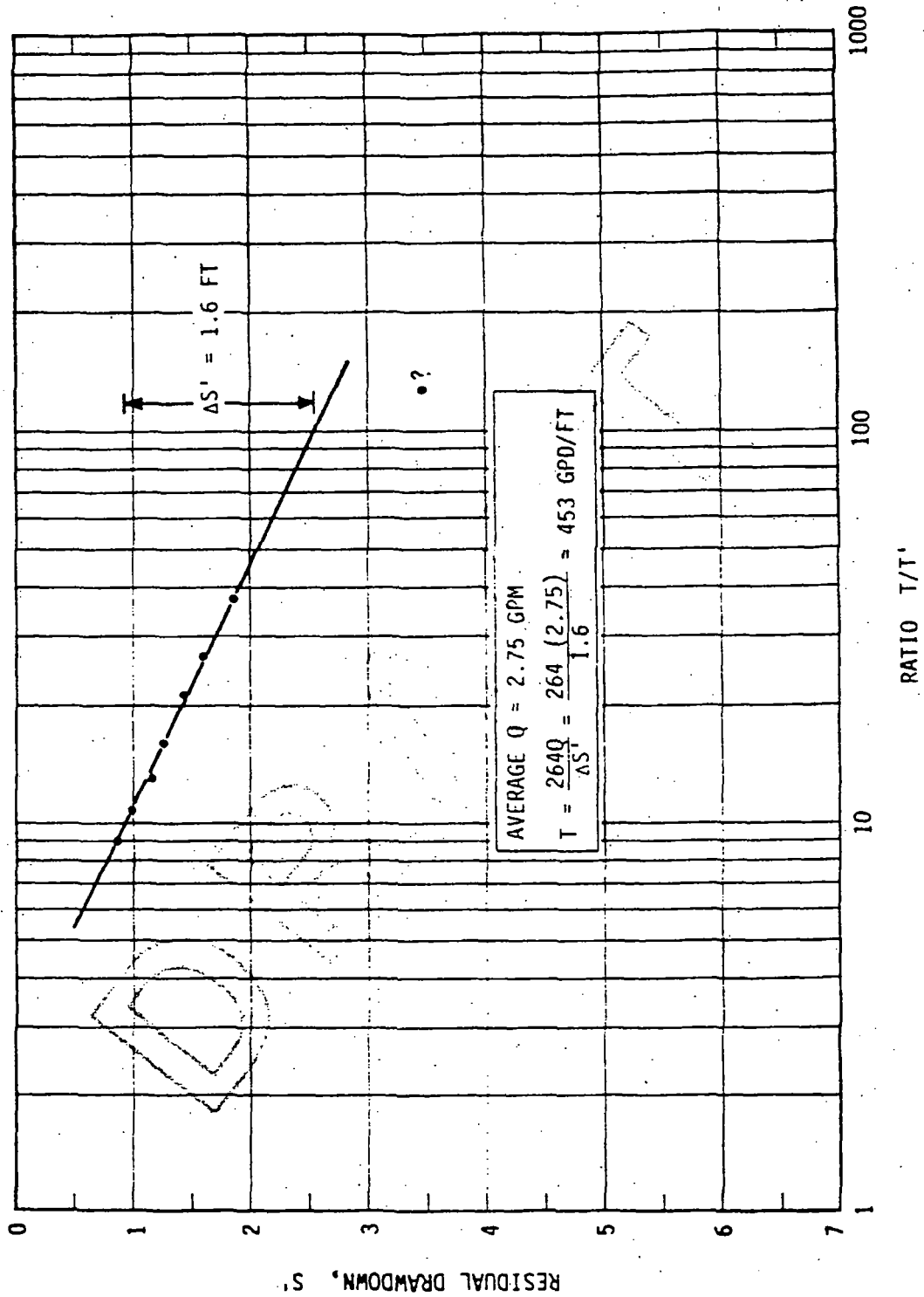
APPENDIX C

TRANSMISSIBILITY CALCULATIONS FOR SELECTED WELLS

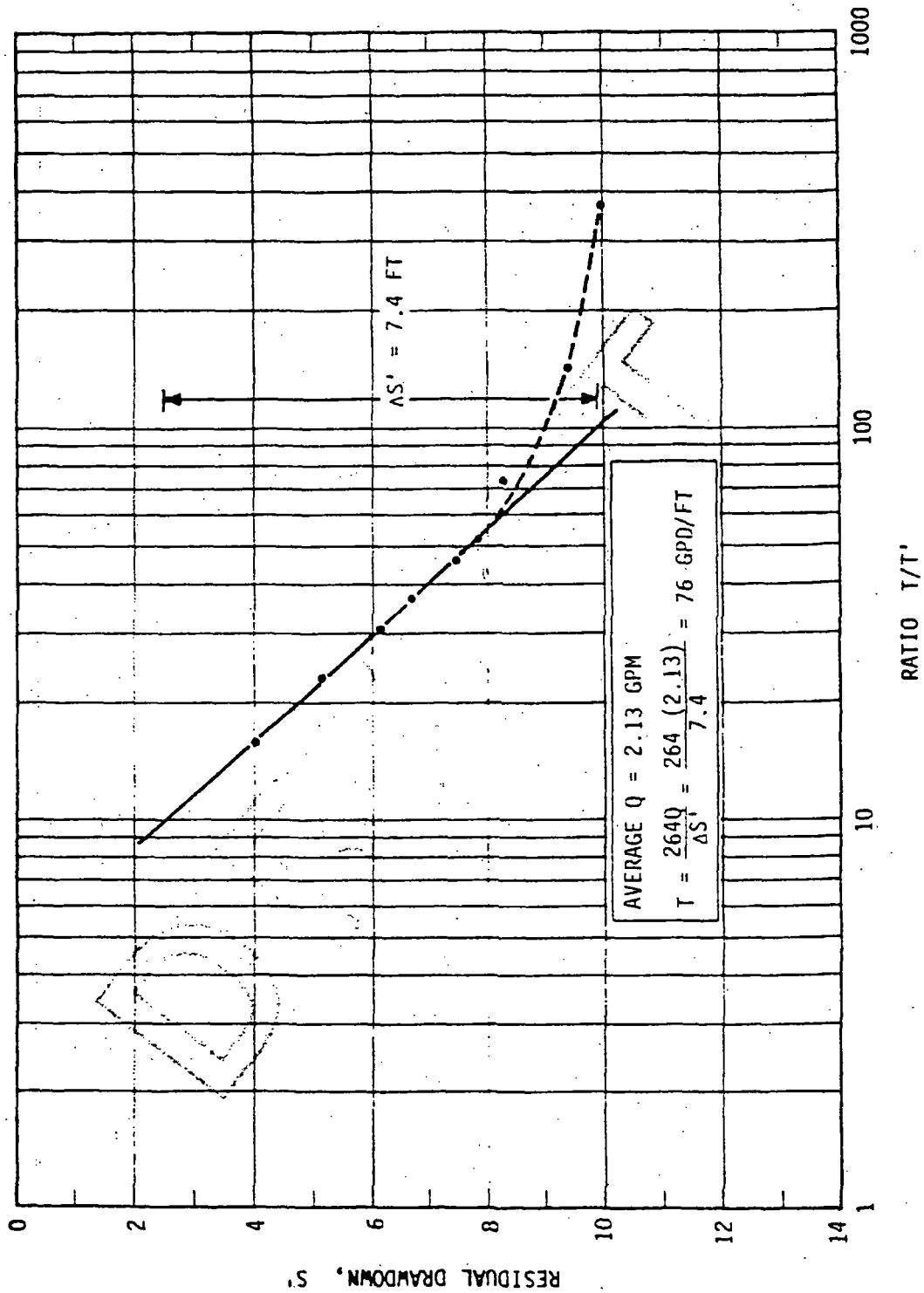
DRAFT



Project No 90029A	PORT QUENDALL Renton, Washington	DRAWDOWN CURVE AND TRANSMISSIVITY CALCULATION FOR BORING 2A	Appendix
Woodward-Clyde Consultants			



Project No. 90029A	PORT QUENDALL Renton, Washington	DRAWDOWN CURVE AND TRANSMISSIVITY CALCULATION FOR BORING 6	Appendix
Woodward-Clyde Consultants			



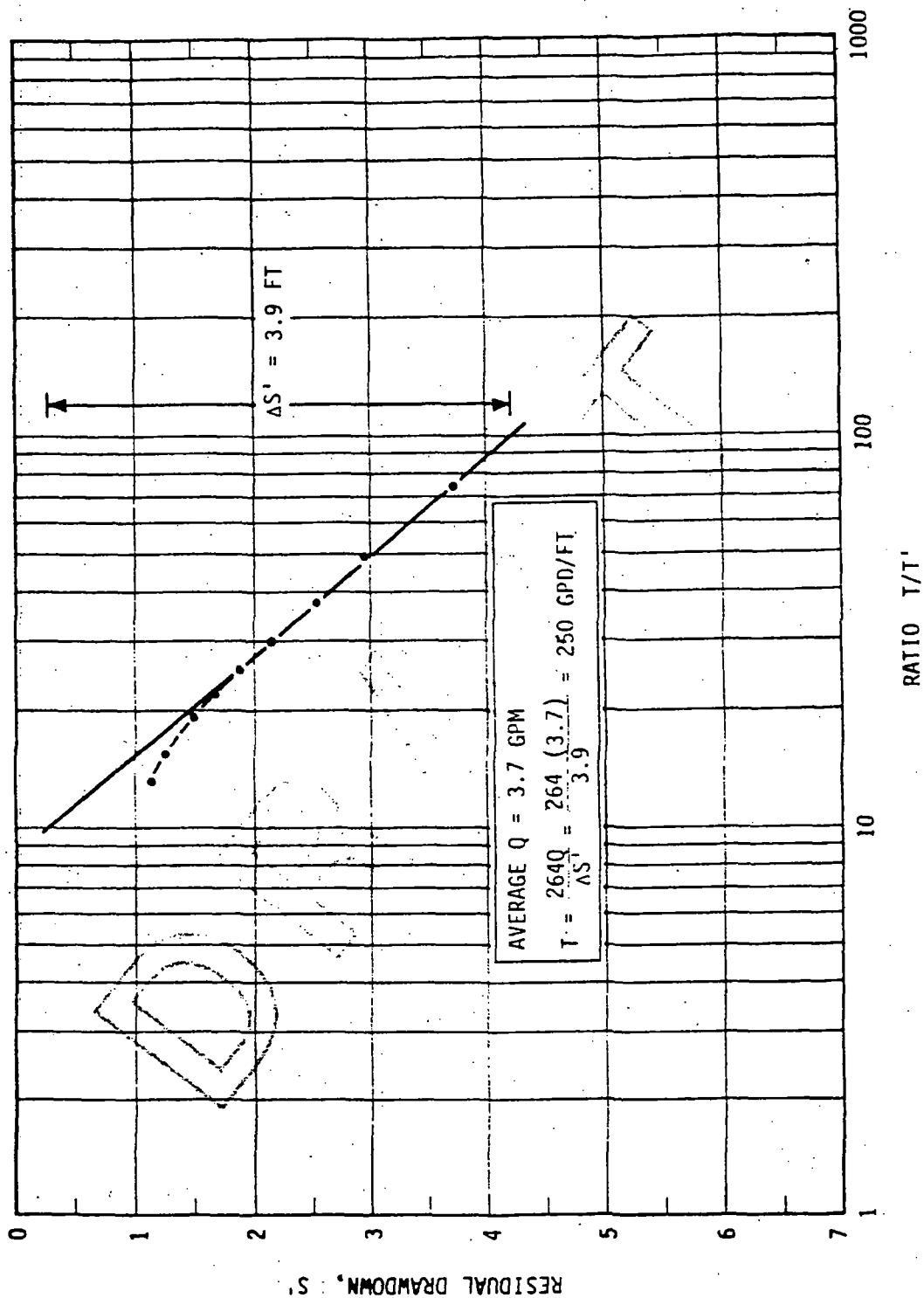
Project No.
90029A

PORT QUENDALL
Renton, Washington

Woodward-Clyde Consultants

DRAWDOWN CURVE AND TRANSMISSIVITY
CALCULATION FOR BORING 8

Appendix



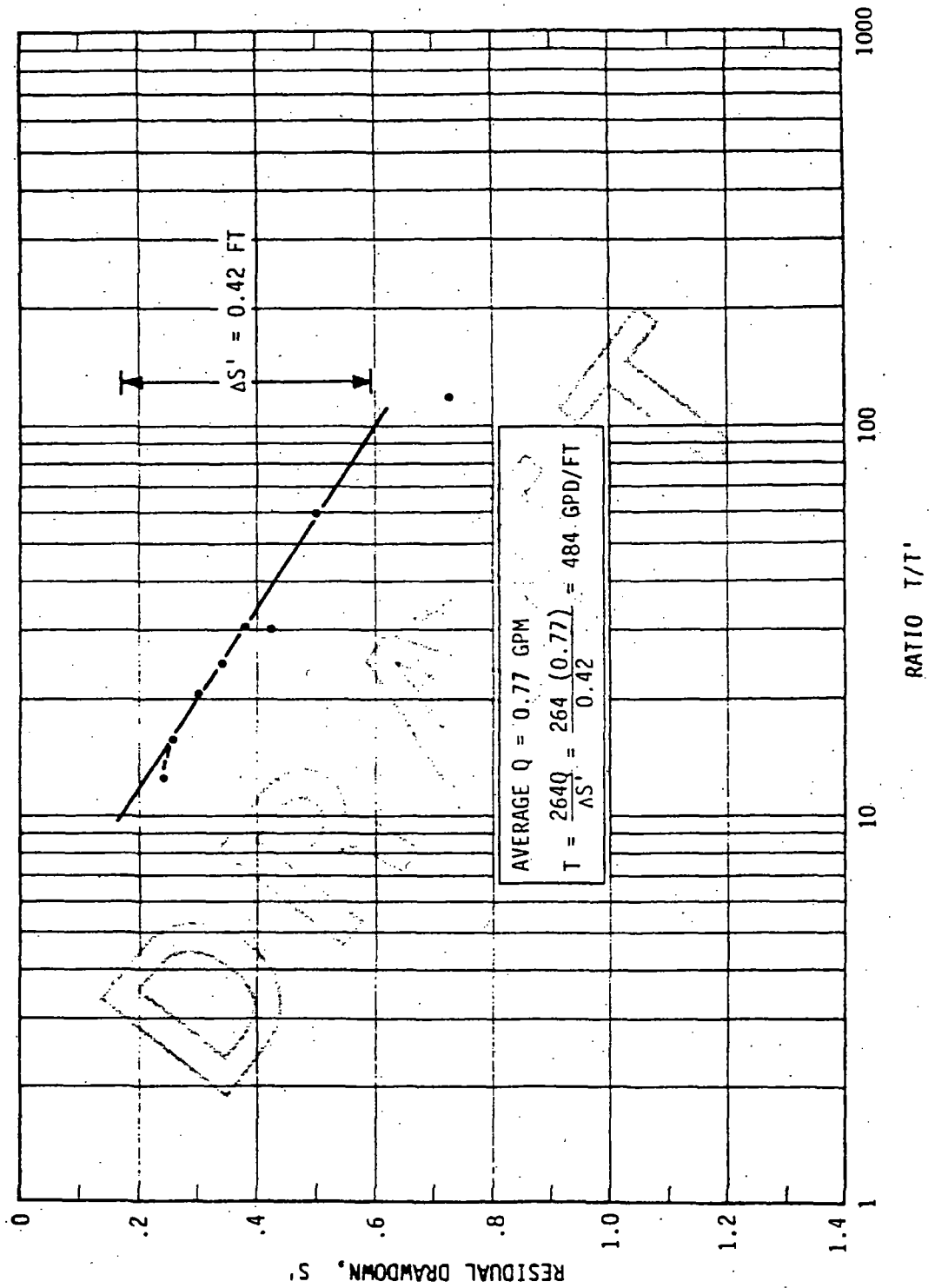
Project No.
90029A

PORT QUENDALL
Renton, Washington

Woodward-Clyde Consultants

DRAWDOWN CURVE AND TRANSMISSIVITY
CALCULATION FOR BORING 10

Appendix



Project No. 90029A	PORT QUENDALL Renton, Washington	DRAWDOWN CURVE AND TRANSMISSIVITY CALCULATION FOR BORING 15	Appendix
Woodward-Clyde Consultants			

APPENDIX D

ANALYTICAL METHODS AND RESULTS

NOTE: Data for samples collected offsite have been deleted from the laboratory data sheets in Sections D-5 and D-6.

DRAFT

APPENDIX D-1
DESCRIPTION OF THE ANALYTICAL
METHODS FOR THE SOIL PAH SCREEN
AND PENTACHLOROPHENOL ANALYSIS OF
WATER

DRAFT

PENTACHLOROPHENOL

(Sep-Pak Method)

1. Sep-Pak extraction.

- a. Take 250 ml sample to 400 ml beaker.
- b. Acidity with 5 ml conc. H_2SO_4 .
- c. Pass through an activated Sep-Pak.
- d. Elute from Sep-Pak with 1.5 ml CH_3CN .
- e. Extract is now ready for analysis.

2. HPLC Analysis.

a. Instrument conditions

Wavelength = 254 nm

Mobile phase = 60% CH_3CN /40% H_2O + 0.1% HOAc

Flow = 1 ml/min

Chart = 0.1 in/min

injection = 25 μ l

AFS = 0.01 AU

Column - Zorbax C18, 5 μ m

- b. Use standards of about 15, 7.5 ppm. This should give a detection limit of about 2 μ g/L.